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THE NORTH AMERICAN SPECIES OF SPHAERALCEA SUBGENUS EUSPHAERALCEA

BY

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BY

THOMAS H. KEARNEY*

INTRODUCTION

THE GENUS *Sphaeralcea* was founded by A. de St. Hilaire (1827),[1] based on a South American species, *S. cisplatina* St. Hil. Four years later Don (1831, p. 465) transferred to *Sphaeralcea* the following species that had been published originally as species of *Malva: umbellata* (Cav.), *rosea* (DC.), *abutiloides* (L.), *obtusiloba* (Hook.), *elegans* (Cav.), and *angustifolia* (Cav.). All these species are still included in the genus *Sphaeralcea* as defined by Bentham and Hooker (1862, pp. 204, 205), Baker (1893, pp. 361–368), and Schumann (1895, pp. 35, 38), although Desvaux (1825) had founded his genus *Phymosia* on the West Indian *Malva abutiloides* L.,[2] and Zuccarini (1831–1836, pp. 359–363) had published a genus, *Meliphlea,* based on *Malva rosea* DC. (*Meliphlea vitifolia* Zucc.). Many additional species of *Sphaeralcea* have been described since, chiefly from North America and extratropical South America, and a few from South Africa.

Accepting, provisionally, the conception of the genus that was held by Bentham and Hooker, Baker, and Schumann, the North American species are comprised in four well-marked subgenera, the characters of which are stated in the following key.[3]

* Bureau of Plant Industry, United States Department of Agriculture.

[1] Full citations of the publications referred to in the text by the name of the author and date of publication are given at the end of the paper.

[2] After these pages were written, the fact that the portion of volume 1 of Fl. Bras. Mer. containing the description of *Sphaeralcea* was issued in 1827, not, as has been supposed, in 1825, was brought to the writer's attention by Dr. B. L. Robinson. Since the name *Phymosia,* therefore, antedates the name *Sphaeralcea* two years, strict adherence to the rule of priority would require adoption of the former name, if it be granted that the *Phymosia* of Desvaux and the *Sphaeralcea* of St. Hilaire are truly congeneric. The writer considers this doubtful and believes that, in any event, the name *Sphaeralcea* should be conserved because of long established usage and the large number of species that have been published under this name.

[3] It is realized that study of the South American and African species might necessitate a revision of this classification and, possibly, the recognition of additional subgenera.

KEY TO THE SUBGENERA OF SPHAERALCEA

A. Carpels not dehiscent to the base, differentiated into a dehiscent, unreticulate, apical portion and an indehiscent, reticulate basal portion, relatively thick, less than 8 mm. high; involucel usually deciduous soon after anthesis, its bractlets subulate; stigmas capitate; ovules 1 to 3; seeds reniform, usually pubescent . . . . *Eusphaeralcea*

AA. Carpels dehiscent to the base, not differentiated apically and basally and without reticulation, thin and flat, 8 mm. high or higher; ovules more than 1.

B. Plant herbaceous above the crown; involucel persistent long after anthesis, its bractlets subulate or narrowly lanceolate; column villous; stigmas capitate; carpels conspicuously bordered on the sides with green, pubescent tissue like that of the back, their pubescence sharply differentiated into short, stellate and much longer, simple, stiff hairs; seeds asymmetrically obovoid, pubescent . . . . *Iliamna*

BB. Plant shrubby or arborescent; column glabrous or nearly so; carpels not conspicuously bordered on the sides, their pubescence all stellate and without sharp differentiation in the length of the hairs; seeds reniform, glabrous.

C. Involucel deciduous soon after anthesis, its bractlets usually separate to the base, lanceolate or narrowly oblong; stigmas capitate . . . . *Phymosia*

CC. Involucel (at least the base) persistent long after anthesis, its bractlets separate or united below, deltoid-ovate, obovate, spatulate, or lanceolate; stigmas obliquely truncate and somewhat introrse . . . . *Meliphlea*

The question, whether any or all of these groups may be entitled to generic rank, cannot be answered authoritatively without an exhaustive investigation of the whole tribe Malveae. The writer therefore prefers to leave them, for the present, in the subgeneric position. Involucels (one each) of the four subgenera are shown in plates 1 and 6. Carpels (one each) of *Meliphlea, Phymosia,* and *Iliamna* are shown in plate 1, twice natural size. In comparing them with the carpels of *Eusphaeralcea,* illustrated in plates 9–12, it should be borne in mind that the latter are enlarged eight times.

The type species of the genus *Sphaeralcea, S. cisplatina* St. Hil. (*S. miniata cisplatina* K. Schum.), a carpel of which is shown in plate 12, *L,* is likewise typical of the subgenus *Eusphaeralcea,* which is well represented in South America, especially in Chile and Argentina. The North American species of this subgenus are almost wholly extratropical.

The subgenus *Eusphaeralcea,* as defined by the writer in the preceding key, comprises the section Pseudo-Malvastrum and most of the section Eusphaeralcea of Baker (1893, pp. 361, 364),[4] the distinction between which is tenuous. The former is characterized as having: "Bracteolae lineares vel lanceolatae. Carpella 1–2-ovulata. Ovula superior etiamsi exsistit rare maturescit." Eusphaeralcea is described as having: "Bracteolae lineares vel lanceolatae liberae. Carpella 2–3-ovulata, 1–3-sperma." The number of ovules is a very unreliable character, varying, not infrequently, in the several carpels of an individual fruit. It should be noted, also, that most of the North American species placed by Baker in his section Pseudo-Malvastrum have two seeds in the carpel, either normally or occasionally.

[4] Baker also included, in his section Eusphaeralcea, species which belong to the subgenera *Iliamna* and *Phymosia,* as defined by the writer.

The genus *Iliamna* of Greene (1906, pp. 206, 207) is confined, with the exception of one species, to the northwestern United States and British Columbia, where it is represented by *S. rivularis* (Doug.) Torrey (*S. acerifolia* Nutt.), *S. longisepala* Torr., *S. grandiflora* Rydb., *S. crandallii* Rydb., and *S. bakeri* Jepson. A sixth species, *S. remota* (Greene) Fernald, occurs in Illinois and southwestern Virginia. In addition to the characters mentioned in the key to the subgenera, the large, thin, maple-like leaves are distinctive. In the writer's opinion, Rydberg (1913, pp. 60, 61) was not justified in transferring these species to *Phymosia,* from which *Iliamna* differs in several important characters.

The genus *Phymosia* of Desvaux (1825) was based on one of the species that Don shortly afterward transferred to *Sphaeralcea,* the West Indian *Malva abutiloides* L. In the characters of the carpels it seems closer to *Meliphlea* than to any other of the subgenera, but is distinguished therefrom by its capitate stigmas and more caducous involucel. No other North American species is certainly referrable to this subgenus, but the writer suspects that *S. floribunda* (Schlecht.) Walp., of southern Mexico, also belongs to *Phymosia.* A specimen in the United States National Herbarium, collected in Oaxaca by Conzatti, corresponding well with the description of *Sphaeroma floribundum* given by Schlechtendahl (1837, pp. 353–354) has narrow bractlets and capitate stigmas.

The genus *Meliphlea* of Zuccarini (1831–1836, pp. 359–363) was based on *M. vitifolia* Zucc., a name cited by Baker (1893, p. 367) as a synonym of *S. umbellata* (Cav.) Don. The gamophyllous involucel, however, as described and figured by Zuccarini, indicates that Standley (1923, p. 767) was correct in referring *M. vitifolia* to *S. rosea* (DC.) Don. In addition to *S. umbellata* and *S. rosea,* this subgenus comprises *S. crenulata* Brandegee and, presumably, *S. nutans* Scheidw. and *S. schenckii* Ulbrich. Gray (1887, pp. 289–291) concluded that *Meliphlea* "is a good genus, upon the characters assigned by its founder, except that the coalition of the bracts of the involucel is inconstant and of no account. The large and thin mellifluous disk, wholly adnate to the calyx tube, is well marked, and the clavate-introrse stigmas help out the character." The disk, which in *S. rosea* is only slightly lobed and in *S. umbellata* is of 5 separate segments (pl. 1, *D*) opposite the calyx lobes, is not, however, a structure peculiar to *Meliphlea.* It is well developed, although smaller and less conspicuous, in the other three subgenera, also (pl. 6, *C*). The stigmas in *S. umbellata, S. rosea,* and *S. crenulata* are as described by Gray, being obliquely truncate and somewhat introrse.

The gap between *Eusphaeralcea* and *Meliphlea,* otherwise very pronounced, is partly bridged by the anomalous *S. endlichii* Ulbrich, of northeastern Mexico. This species has the subulate, caducous bractlets and capitate stigmas of *Eusphaeralcea,* but the carpels (pl. 12, *J, K*) are large for that subgenus and resemble those of *Meliphlea* in being almost completely dehiscent and in showing, at most, a mere trace of reticulation at base.

SPHAERALCEA AND MALVASTRUM

When Gray (1849, p. 21) published his genus *Malvastrum,* he did not compare it with *Sphaeralcea,* although several species of the latter genus were described in the same paper. Bentham and Hooker (1862, pp. 197–205) placed these genera in different subtribes of the tribe Malveae: *Malvastrum* in Eumalveae, with the ovule solitary; and *Sphaeralcea* in Abutileae, with ovules 2 to many. Comparison of the descriptions of these genera in the Genera Plantarum shows no other important distinguishing character. Schumann (1895, pp. 35–41) likewise gives virtually only this one diagnostic character, although he, also, assigns the two genera to different subtribes of the tribe Malveae, *Sphaeralcea* to Abutilinae, and *Malvastrum* to Malvinae. A closer relationship of these genera is recognized by Gray, who in his latest treatment of the family (1897, p. 296) referred both genera to the subtribe Sideae. The unsatisfactory nature of the distinction between *Sphaeralcea* and *Malvastrum,* as they had been defined previously, was made clear by Gray in a previous revision of these genera (1887). He states (p. 287):

> When the first-named genus [*Malvastrum*] was founded, no one supposed that in the principal North American species it came so very near to *Sphaeralcea*.... The difficulty in this respect soon became apparent.... Although the two genera in question are essentially confluent through certain species, they really ought not to be combined under *Sphaeralcea,* nor can they be distinguished, as was supposed, by the number of ovules or seeds. The practical course, in my opinion, is to retain in *Malvastrum* the species with cell of the carpels conformed to the solitary ovule and seed, therefore with no empty terminal portion; and to refer to *Sphaeralcea* those with solitary or occasionally two ovules, which when the upper ovule is either abortive or wanting have the upper part, usually the whole upper half, of the mature carpel empty, and of a different texture from the lower part, being thin and smooth, while the lower has rugose-reticulated sides.

Most of the species assigned to *Malvastrum* by Gray in his revision of 1887 conform to his definition of the genus as given in the preceding paragraph, but *M. coccineum* and *M. leptophyllum* do not, and should have been transferred to *Sphaeralcea,* as was done later by Rydberg (1913, pp. 57–59). Baker (1891, p. 164) followed Gray's suggestion in defining *Malvastrum* as having "carpella seminibus conformia apice producto vacuo nullo," but retained in the genus *M. coccineum* and *M. leptophyllum,* which have a well-defined, although small, unreticulate, dehiscent apical extension (pl. 12, *G, H*).[5]

It is the writer's opinion that much further investigation is necessary before the genera of the tribe Malveae can be defined satisfactorily. Such a study, involving all the genera and species in all parts of the world, is beyond the scope of the present paper, but the genera *Sphaeralcea* and *Malvastrum,*

[5] Hochreutiner (1919–22*a*, p. 378) suggests that *Malvastrum* (and, inferentially, the normally 1-seeded species of *Sphaeralcea*) represent a more advanced stage of development. He refers to *M. wilczekii* Hochr. "qui dérive des *Sphaeralcea* pluriseminés, comme la majorité ou la totalité des *Malvastrum.*"

so far, at least, as they are represented in North America, may be defined, provisionally, as follows:

Sphaeralcea: Ovules more than 1, or if only 1, carpels sharply differentiated into a dehiscent, unreticulate, apical portion and an indehiscent, reticulate, basal portion.

Malvastrum: Ovule 1,[6] carpels not differentiated, apically and basally.

A nomenclatorial dilemma is created by the transfer to *Sphaeralcea* of the first three species cited by Gray in his original description of the genus *Malvastrum* (1849, p. 21). The second and third species, *M. grossulariaefolium* and *M. munroanum,* were later recognized as species of *Sphaeralcea* by Gray himself (the former under the name *S. pedata* Torr.). The first-cited species, *M. coccineum,* which must be regarded as the type of the genus, was transferred subsequently to *Sphaeralcea* by Rydberg (1913, p. 58); correctly so, in the writer's opinion.[7] Unfortunately, this disposition of the type species seems to invalidate the name Malvastrum, yet the writer believes that, with the exception of *M. coccineum* and *M. leptophyllum,* none of the species referred to *Malvastrum* by Gray in his later revisions of the genus (1887, 1897) may be regarded as belonging properly to *Sphaeralcea.*[8]

The fourth species cited by Gray in his original description of the genus *Malvastrum, M. fremontii* Torr., belongs to a rather homogeneous group of California species, characterized by suffrutescent or suffruticose stems, pink or lavender petals, and 1-ovuled carpels that are undifferentiated and without reticulation and are promptly and completely dehiscent on both edges (pl. 2, *A*, *B*). These species constitute the genus *Malacothamnus* of Greene (1906, pp. 207, 208); they were transferred to *Sphaeralcea* by Jepson (1925, pp. 633, 634). They are, indeed, not unlike some species of *Eusphaeralcea* in habit and appearance. Nevertheless, such disposal of these species would not be justifiable unless the whole genus *Malvastrum* is to be merged with *Sphaeralcea.* It is the writer's judgment that combining these genera would only increase the existing confusion as to generic limits in the tribe Malveae. It would seem the better course to retain *Malacothamnus* as a well-marked subgenus of *Malvastrum,* pending a thorough revision of the genera of this tribe.

Cytological evidence supports the conclusion that the *Malacothamnus* group of *Malvastrum* is generically distinct from *Sphaeralcea.* The writer's

[6] The South African *M. virgatum* Gray and Harv. sometimes has two ovules and even two developed seeds in a carpel, according to Hochreutiner (1919–22*b*, p. 421).

[7] No species has more typical *Eusphaeralcea* carpels than *S. subhastata* Coult. (pl. 11, *G*), yet there is complete intergradation, through subsp. *pumila* (pl. 11, *I*) with *S. coccinea* (pl. 12, *H*), through subspp. *elata* (pl. 12, *I*). When these several forms are seen in the field, the fact that they are congeneric cannot be doubted. Moreover, it has been discovered by J. M. Webber that in *coccinea* the haploid number of chromosomes is 15, conforming to the basal number of Eusphaeralcea, $n = 5$; whereas, in the few species of *Malvastrum* so far investigated, the number is not 5 or a multiple thereof.

[8] If conservation of the name Malvastrum be regarded as impracticable, Presl's older name Malveopsis, which was taken up for Malvastrum by Kuntze (1891, pp. 71, 72), would seem to be applicable. Baker (1894) finally concluded that the species, *Malva anomala* Link and Otto, on which Presl (1844, pp. 448, 449) based his briefly and rather vaguely characterized genus *Malveopsis,* is identical with or closely related to *Malvastrum capense* Gray and Harvey. The latter species appears to be congeneric with the tropical and subtropical American species of which *M. coromandelianum* (L.) Garcke is representative.

colleague, Dr. J. M. Webber, has found the haploid number of chromosomes to be 17 in *Malvastrum fasciculatum* (Nutt.) Greene[9] and 5, or multiples thereof, in *Eusphaeralcea.* He noted, also, that the cotyledons of *M. fasciculatum* are rounded at apex, while in *Eusphaeralcea* they are acutish.

Malvastrum angustum Gray, an inhabitant of the Mississippi Valley region, resembles the California group (*Malacothamnus* of Greene) in having the carpels promptly and completely dehiscent along both edges (pl. 2, *C, D*); but it is a small, herbaceous annual with yellow petals.

The remaining North American species that were assigned to *Malvastrum* by Gray have the carpels indehiscent or tardily dehiscent ventrally, and, in several species, radially rugose (pl. 2, *E-H*). Three of these, *M. exile* Gray, *M. rotundifolium* Gray, and *M. parryi* Greene, are herbaceous annuals with white or purple petals, constituting the genus *Eremalche* of Greene (1906, p. 208). They, also, were transferred to *Sphaeralcea* by Jepson (1925, p. 633), but the relationship appears to be as remote as it is with *Malacothamnus.* On the whole, it seems best, for the present, to regard *Eremalche* as congeneric with the tropical and subtropical species constituting the residue of the genus *Malvastrum* in North America, as that genus was understood by Gray and by Baker. This residue comprises, for the most part, woody plants with yellow petals but includes more than one herbaceous species and at least two species with purple petals.

CHARACTERS OF THE NORTH AMERICAN EUSPHAERALCEAE

THE RANGE OF VARIATION of the characters in *Eusphaeralcea* is indicated in the following paragraphs, which thus constitute a description of the subgenus as represented in North America. As a rule, no description is given of characters common to the family, tribe, and genus. This chapter also defines the characters used in the keys and descriptions of species, indicating the method of measurement of characters that were determined quantitatively.

Particular consideration is given to characters of diagnostic value in distinguishing the sections and species, and those instances are indicated in which the variation throughout the subgenus is so small as to make it unnecessary to mention the character in the descriptions of the several species. For example, the word "stellate" will be omitted in describing the hairs of the stems, leaves, and calyx, which are invariably of this character. Also, the stipules and bracts, including the bractlets of the involucel, and the flowers in most of their characters, are so similar in nearly all the species that they will be mentioned only when some exceptional feature appears. In general, therefore, characters showing no departure from the norm of the subgenus, as set forth in the following paragraphs, are omitted in the descriptions of species.

Longevity.—Most of the species are perennial, but few of them are long-lived. A few species, especially in the section Coulterianae, are annual or bien-

[9] In *M. capense* Harvey and Gray, Stenar (1925, p. 48) reported the haploid number of chromosomes to be 21.

nial. The habit and appearance of representative plants of *Eusphaeralcea* are shown in plates 3 and 4.

Roots and stems.—The taproot usually is well developed, varying, in the several species, from slender to very stout. The flowering stems of the perennial species usually arise from a well-defined crown at or just below the surface of the soil, and this frequently is very stout and lignescent, even in species of which the stems are otherwise herbaceous. In a few perennial species (*hastulata, subhastata, coccinea*) there is often no distinct crown, the flowering stems originating, apparently as root shoots, considerably below the surface of the soil.

The flowering stems are usually herbaceous above the crown, even in the perennial species, but are sometimes suffrutescent or even suffruticose, especially in the Ambiguae. In several species they are very numerous, being often 50 or more in *ambigua* and *emoryi.* Although usually erect or ascending, in some of the sections (Pedatifidae, Lindheimerianae, Hastulatae, Coccineae) they are often decumbent. In length, measured from the crown, they range from 10 cm. to 360 cm., the minimum length having been recorded in *hastulata, subhastata,* and *coccinea,* and the maximum length in *coulteri californica.* The diameter at base varies from 1 to 10 mm., the maximum having been observed in *orcuttii.* The stems are often sparingly branched above the crown, especially if the terminal bud has been injured. They are usually approximately terete, but in one species (*palmeri*) they are conspicuously angled.

Leaves.—The stipules vary little throughout the subgenus, being membranous, narrowly lanceolate, attenuate-acuminate, pubescent, and caducous. They resemble the bractlets of the involucel, but usually are broader and longer.

The petiole varies greatly in length relative to that of the blade, being from one-eighth as long to considerably longer. Usually there is great variation within the species. As a rule, in adult leaves of the flowering stems the petiole is from one-half as long to as long as the blade. The characters of the petiole usually are of little diagnostic value.

The blades of the first few leaves above the cotyledons, in nearly all the species of which seedlings have been examined, are ovate and nearly entire to sparingly crenate or dentate, but not lobed. This was found to be true even in certain species (*rusbyi, digitata*) which have the adult leaves pedately parted or divided (pl. 5).[10] The remarks that follow apply only to the larger adult leaves of the flowering stems.

The blades vary from thin to thick; if thick, the veins are usually impressed above and very prominent beneath. In many species, young leaves and leaves of plants growing in partial shade have thin, not densely pubescent blades with only slightly prominent veins, while the older leaves, especially those produced in exposed situations and during the dry season, are much thicker, rugose-veined beneath, and densely canescent or tomentose. Mature

[10] In *S. pedatifida* and *S. coccinea,* however, the first leaf above the cotyledons is sometimes distinctly, though not very deeply, cleft.

leaves usually are more pubescent on the lower than on the upper surface. The young leaf blades usually are flat and in several species the margins of the older blades often are conspicuously ruffled and revolute.

The length of the blade (always measured from the base of the midvein and hence not the maximum length in cordate leaves) varies from 1 to 12.5 cm. The width at the widest point (in lobed leaves measured from tip to tip of the larger lateral lobes) varies from one-tenth of the length to one-third or even one-half greater than the length. In shape, the leaf blades vary from linear-lanceolate to broadly deltoid-ovate, nearly orbicular or, occasionally, subrhomboidal. The character of the apex varies from very obtuse or even truncate (occasionally retuse and mucronate) to acuminate; and that of the base from deeply cordate to strongly cuneate. The margins vary from obscurely crenulate (rarely entire) to coarsely crenate or dentate, or even irregularly and pinnately cleft, the last condition being usually aberrant.

The primary veins, those arising at the summit of the petiole, are usually 3 in the narrow-leafed forms, 5 in the broad-leafed forms. The lobation, seldom entirely lacking, may be represented merely by a pair of subhastate teeth or angles near the base of the blade, with every gradation from this condition to the pedately parted or divided blade characteristic of several species. Usually, the blade is 3-cleft, parted or divided, but the lateral lobes, in some species, are so deeply cleft as to give the appearance of a 5-lobed blade. The lobes vary from broad and rounded to narrow and acute. In species with pedate blades, they are cuneate-obovate or oblanceolate. In one species (*pedatifida*) they are frequently bristle-tipped. The length of the mid-lobe, relative to that of the longest lateral lobe (as measured from the base of the cleft) varies from little longer to 20 or more times as long in species that have the lobes reduced to subhastate basal teeth (*angustifolia, subhastata*).

Pubescence of stems and leaves.—The hairs of the flowering stems and of the leaves are similar, although they are frequently somewhat longer on the lower leaf-surface than elsewhere. In order to express this character comparably, as among the several species, the hairs on which were determined the length and number of rays, as recorded in the descriptions of species, were taken, in all specimens, from a small area of the stem near the base of the inflorescence.

The hairs of these organs are invariably stellate in *Eusphaeralcea*. In nearly all the species they are of the type designated "Sternhaare" by Netolitzky (1932, p. 19), with rays approximately horizontal to the surface of the organ bearing them, as distinguished from "Büschelhaare," in which the rays are perpendicular to the surface. The hairs of the petals and staminal column, and such of the seed hairs as are multicellular, are of the perpendicular type. In only one species (*leptophylla*) the hairs of the stem, leaf, and calyx are typical shield hairs, which, as described by Netolitzky, are derived from stellate hairs by lateral union of the rays. An approach to this condition is seen in *coccinea,* in which the rays often are united for a short distance above the base. In the other species the rays are distinct to the base or nearly so.

The rays, which are unicellular, vary in number from 4 to 25 or more and in length from 0.1 to 0.8 mm., attaining a length of 1 to 1.5 mm. normally in only one species (*lindheimeri*), but occasionally in *pedatifida.* They are very thin-walled and somewhat flaccid in some species, much thicker-walled and stiffer in others. In all these characters there is much variation, not only from species to species, but within most of the species and within a very small area on the same individual plant. Even the rays of a single hair often differ greatly in length.

The pubescence of the stems and leaves, at least when young, commonly is very dense, but in several species the stems often become glabrescent with age. In many of the species the dense canescence or tomentum gives the plant a whitish, grayish, or yellowish appearance.

Inflorescence.—The inflorescence is, typically, a narrow, elongate thyrse (pl. 4) composed of short, few-flowered, simple or branched racemes, the axes of which are often so much shortened as to give the appearance of a corymb. Even when the racemes are well developed, accessory flowers on pedicels arising directly from the leaf axils are of frequent occurrence. In a few species (*ambigua, laxa*) the inflorescence is more openly paniculate (pl. 3). In other species (*lindheimeri, hastulata, subhastata, coccinea, endlichii*) the whole inflorescence is a simple raceme or a much reduced thyrse with, at most, 2 or 3 flowers at each of the lower nodes. The subtending leaves are well developed at the lower nodes but at the upper nodes are usually so reduced that the terminal portion of the inflorescence appears naked. Some species (*orcuttii, incana*) are extremely floriferous, with several hundred flowers to the stem, but in other species (*subhastata, coccinea*) the number commonly does not exceed 10 or 12.

The pedicels usually are shorter than the calyx and relatively stout, but in a few species they are often much longer than the calyx and are slender. In some species (notably the Fendlerianae) they are very tough and persistent, and in others (especially the Hastulatae) they separate by abscission so that the whole fruit falls from the plant as soon as it matures.

Involucel.—In nearly all the species, the involucel consists of 3 bractlets that are separate and remote from one another, and free from the calyx (pl. 6, *A*). They are attached to the pedicel at or very near the base of the calyx tube. Usually they are one-third to two-thirds as long as the calyx, rarely equaling it. The bractlets are filiform, subulate, or very narrowly linear-lanceolate, membranous, greenish at first, and more or less pubescent with stellate hairs. In most of the species they are caducous, dropping off soon after anthesis and often turning dark red before they fall. In *pedatifida,* however, they sometimes persist until maturity of the fruit and also have the peculiarity of being often denticulate. In only one species (*coccinea*) the involucel usually is wanting and consists, when present, of fewer than 3 bractlets.

Calyx.—The calyx (pl. 6, *A* and *C*) is usually about one-half as high as the corolla and is 5-lobed, with lobes 1 to 3 (rarely 5) times as long as the tube and varying in shape from deltoid and acute to lanceolate and attenuate-

acuminate. If the calyx surpasses the fruit, its lobes are usually connivent until full maturity of the fruit. The calyx is more or less pubescent externally, usually densely so, with hairs similar to those of the stems and leaves. The pubescence usually is denser on the tube and on the margins of the lobes, and the marginal hairs are shorter than the others. Very dense and short pubescence, similar to that of the margins, often occurs also on the inner surface of the tips of the lobes, the calyx being, otherwise, glabrous internally. In a few species (*palmeri, leptophylla, endlichii*) the calyx is often conspicuously angulate-ribbed, especially in the bud.

At the bottom of the calyx, and closely adnate to the inner surface of the tube, there is a thin nectariferous disk of five separate, truncate or emarginate, approximately rectangular segments (pl. 6, *C*). These are opposite the calyx lobes, they are much shorter than the tube, and are concealed by the base of the staminal column.

Corolla.—There is relatively little variation in the characters of the corolla. The five asymmetrical petals usually are broadly obovate, being, at the apex, from about two-thirds to equally as wide as long; but normally in the Sulphureae, and exceptionally in a few other species, they are oblanceolate and not more than one-half as wide as long. In most of the species they range from 1 to 2 cm. long, but they attain a length of 3.5 cm. in *ambigua,* the largest-flowered of the North American species. Aberrant forms, with flowers not more than half the size normal to the species, have been observed in several species (*orcuttii, hastulata, subhastata*).

The petals are usually emarginate and are sometimes erose. Their claws are usually very short and broad, but are relatively long and narrow in Sulphureae. They are densely ciliate or bearded at or near the base (pl. 5, *E*) with few- (2- to 6-) rayed hairs, 0.5 to 1.0 mm. long; hence, in many of the species, much longer than the stem hairs. The ciliation extends for a distance of 0.5 to 3 mm. along the edge of the petal.

The normal color of the blade of the petal is grenadine pink to grenadine red in a great majority of the species but orange or yellow in sections Coulterianae and Sulphureae; and these colors change little in drying. Variation to pink, lavender (often drying violet), and white occurs in several species that usually have grenadine petals and these colors are normal in two species (*axillaris, angustifolia* f. *typica*).[11] Petals with grenadine-colored blades have the claws light green or greenish yellow, and petals with pink, lavender, or white blades have whitish or very pale green claws. Occasionally, on pink or purple petals, there is a distinct, sometimes fimbriate-margined "eye" of slightly deeper color, above the claw.

Stamens and pistils.—The highly developed staminal column (pl. 6, *B*) varies in length from about 4 to about 10 mm., reaching its maximum length

[11] By comparison of the petals of fresh flowers of *emoryi variabilis* and *ambigua rosacea* with the standards of Ridgway (1912), the following tints and shades, in addition to grenadine, were recognized: white, white tinged with pink, pale amparo purple, mallow pink, amaranth pink, rose pink, deep rose pink, pale rose purple, rose purple, liseran purple, pale rosolane purple, deep lavender, light pinkish lilac, pale vinaceous lilac, jasper red.

in large-flowered species such as *ambigua*. There is also considerable variation in the thickness of the column, and in the degree to which the stamens are aggregated toward the summit. The part of the column below the filaments varies from glabrous to rather copiously pubescent, but is constantly glabrous in none of the North American species. The hairs are 4- to 8-rayed, hence fewer rayed in most of the species than the hairs of stem and leaf, but more numerously rayed than the hairs of the petals. The hairs vary from 0.4 to 0.8 mm. long, hence are usually longer than the stem and leaf hairs.

The number of the numerous stamens, the length of the filaments, and the shape of the anthers (pl. 6, *B*) seem to offer no characters of especial diagnostic worth. In most of the species, the anthers are normally cream-colored or yellowish, but often vary to purplish, especially in forms having pink or lavender petals. They are normally dark purple in 3 species that are not known to have other than grenadine-colored petals (*laxa, rusbyi, digitata*). The filaments vary from nearly white to pink or purple. The pollen is usually yellow.

The styles and the capitate stigmas (pl. 6, *B*) vary in color from nearly white to deep red and dark purple.

On the whole, few characters of these organs are of value in distinguishing the species.

Fruit.—The characters of the fruit are of great diagnostic value, and identification is often difficult in the absence of mature fruit. The number of carpels ranges, in the subgenus, from 7 to 22, but in most of the species, the variation is approximately from 10 to 16. Until maturity, the carpels are closely serried, forming an apically depressed fruit that varies in shape from lower than hemispherical to truncate-conical. In the former shape it is usually much lower than the calyx, while in the latter shape it usually nearly equals or even surpasses the calyx.

The mode of attachment of the carpels is interesting (pl. 7, *A*). The receptacle is enlarged at the summit and has a projecting "shelf" at the base. The carpels adhere to the upper enlargement by their ventral notches. Before they mature, it is difficult to detach them at this point, the notch being closely packed with receptacular tissue, but at maturity shrinkage of this tissue allows the carpels to detach themselves from the upper part of the receptacle. This attachment seems to be purely mechanical, the vascular connection of the carpels with the receptacle being by "threads," as Gray designated them.[12]

The carpellary threads are attached at one end to the receptacle, just above its lower projection or shelf, where, apparently, they branch from the vertical (presumably fibrovascular) ribs of the receptacle. At the other end they are attached to the middle of the back of the carpel, usually near its base. Above the point of attachment the thread forms part of the midrib of the carpel. This structure is fibrovascular, A. E. Longley having demonstrated, in *fendleri,* the existence of spiral tracheids throughout its length. It may be regarded

[12] The term "carpophore," used by Hochreutiner (1919–22*a*, pp. 364, 365) to designate these structures, does not seem entirely appropriate.

as constituting the petiole of the carpellary leaf. In detaching the carpel from the receptacle, it seems to be largely a matter of chance whether most or all of the thread adheres to the carpel or to the receptacle. Anastomosis of the threads, making it difficult to separate adjacent carpels, has been observed in *angustifolia.*

There is much variation in the length, toughness, and persistence of these structures. They are especially well developed in Fendlerianae, in which section every carpel is attached to the receptacle by a tough thread that is often, measured from its point of attachment to the carpel, one-half the length of the carpel, and that persists long after complete maturity of the fruit and dehiscence of the upper part of the carpel (pl. 7, *A*). In this section, the attachment is well above the base, usually about opposite the notch. In other sections (Coulterianae, Ambiguae, etc.) the threads are much more delicate, fragile, and fugacious, often extremely short and apparently lacking entirely on some of the carpels of an individual fruit. The attachment in these groups is more nearly basal, and the threads are sometimes difficult to detect in mature fruits. It is probable, however, that they are not lacking entirely in any species of *Eusphaeralcea*[13] and they are highly developed also in the subgenera *Iliamna* and *Meliphlea,* less so in *Phymosia* (pl. 1, *E-G*).

There are great differences in the size of the carpels, not only from species to species, but often within the species (pls. 9–12). They range in height from 1 to 6 mm., as measured in the natural position and excluding the cusp, when present. In the anomalous *endlichii,* they sometimes reach a height of 8 mm. In width (measured at the point of maximum width, whether occurring above or below the notch) they vary from less than one-half of to more than the height. The shape varies from oblong or oblong-lanceolate to nearly orbicular. In some species (notably *ambigua*) in which the ventral notch is very deep and has its upper edge extended into a prominent "beak," the shape of the carpel is strikingly galeate. There is much variation in the subgenus in the relative depth and width of the notch and in the prominence of the beak.

The carpels, when mature, separate freely from one another in most of the species, but in several are more or less connate by their ventral edges toward the apex, so that they cannot be separated without tearing them. Sometimes they are connate by pairs and sometimes all the carpels are united so that the whole fruit detaches itself from the upper part of the receptacle as a closed ring. This extreme development of connation is seen in *angustifolia* (especially the typical form), in some forms of *subhastata,* and in *endlichii.*

The walls of the carpels vary in texture from scarious and fragile (Pedatifidae, Coulterianae) to coriaceous and tough (Coccineae). In most of the species the texture may be characterized as chartaceous.

Differentiation of the carpel into an upper, dehiscent, unreticulate section and a lower, indehiscent, reticulate section, with the bottom of the ventral

13 Gray (1887, pp. 291, 292) gives as one of the characters for distinguishing the "Malvastriform species" from the "true Sphaeralceae," the absence, in the former, of a "retaining thread." It would have been correct to state that the threads are less developed in several species of the former group.

notch marking the point of differentiation, is the most striking characteristic of the subgenus *Eusphaeralcea* (pls. 9–12). The reticulations are, however, often scarcely perceptible in immature carpels, and in some of the Fendlerianae they are frequently very faint, even at maturity (pl. 10, *I*; pl. 11, *A, B*). They are reduced almost or quite to the vanishing point in *endlichii*, which is referred, doubtfully, to this subgenus (pl. 12, *J, K*). Sometimes the dehiscent, sometimes the indehiscent section constitutes the greater portion of the carpel, the proportion varying from one-tenth to nine-tenths indehiscent. The two sections are usually about equal in width, but in several species, especially those having a greatly reduced dehiscent section, the indehiscent section is much the wider, and in a few species (Emoryanae in part, *S. laxa*) it is noticeably narrower than the dehiscent section (pl. 10, *A, C, F*).

The dehiscent, apical portion is usually broadly ovate or deltoid, erect, and pointed or rounded at apex; but in species in which it is much reduced, it is commonly more or less quadrangular, ascending or even horizontal, and truncate at apex. It varies from muticous to cuspidate, becoming bimucronate or bicuspidate on dehiscence; or the cusp is sometimes initially bifurcate, according to Hochreutiner (1919–22*a*, p. 381). The cusps, which in some species attain a length of nearly 2 mm., are usually placed at the dorsal (rarely at the ventral) edge of the carpel and are usually ascending. This character is highly variable in many of the species. Even the carpels of a single fruit may vary from muticous to distinctly cuspidate. The back of the dehiscent portion is pubescent, usually densely so, especially near the apex, with stellate hairs similar to those of the vegetative organs. Such hairs occur also on the cusps. Relatively thick pubescent tissue, similar to that of the back, borders the otherwise thinner and glabrous sides of the dehiscent section. In a few species (*angustifolia, subhastata, endlichii*) a few spinules are found occasionally on the back of the carpel near its apex, and on the basal part of the cusps, but this appears to be a very inconstant character.

In several species, the dorsal rib is infolded at or near the base of the dehiscent portion, forming a palate-like projection into the cavity. This structure is most highly developed in the Coccineae, but was noted also in several other species that have a relatively small dehiscent portion (*pedatifida, orcuttii, lindheimeri, hastulata*). In species having a relatively large dehiscent section, it is absent or less prominently developed. Hochreutiner (1919–22*a*, pp. 357–361) applies the term "endoglossum" to the structure concerned, which reaches its highest development in the genus *Gaya* but of which he remarks, "nous l'avons rencontré chez plusieurs *Sphaeralcea*." He notes that it is associated with achene-like, one-seeded carpels and conjectures that it has the function of helping to retain the seed below it. The endoglossum is composed almost entirely of fibrous tissue, according to this authority (p. 376).

The reticulation of the indehiscent portion of the carpel varies greatly from species to species, and often within the species, in the prominence of the ribs and the size of the areolae. The areolae, in species having very thin-walled carpels, are very nearly transparent. The ribs, in several species in which they

are very prominent, frequently become nearly black at maturity (pl. 9, *A-C, K*). The back of the reticulate section varies from smooth to markedly rugose and in several species (*pedatifida, hastulata, subhastata*) it is often conspicuously muricate (pl. 11, *F-I*).

Ovules and seeds.—The number of ovules is normally either 1 or 2, but most of the species in which the ovule usually is solitary occasionally have 2 ovules in a carpel, and species in which 2 is the normal number sometimes have 3. There is often variation among the carpels of a single fruit in this respect.

The number of seeds varies from 1 to 3, one of the ovules (usually the upper one) frequently failing to develop in carpels containing more than one ovule. Here, also, there is often variation in a single fruit. The seeds show relatively little variation in size, shape, and color, being reniform and, when mature, dark brown (pl. 7, *B*). The seed usually is larger when only one develops in a carpel. The maximum diameter observed in *Eusphaeralcea* was 2.0 mm. The seeds are usually sparsely to copiously pubescent, seldom glabrous. The seed hairs of *Eusphaeralcea*, unlike those of other parts of the plant, are often simple, but hairs with 2 or 3 rays also occur. These hairs are very short, varying from 0.1 to 0.25 mm. in length.

VARIABILITY AND HYBRIDIZATION

Most of the North American species of *Eusphaeralcea*, especially the abundant and widely distributed ones, are exceedingly variable (pl. 8). The diversity is so great that much difficulty has been encountered in preparing descriptions and in constructing workable keys.

Closely related species usually are found to be connected by numerous intermediate forms and sometimes even species assigned to different sections of the subgenus apparently intergrade. It would seem that the group is in a state of active evolution and that many of the species have not yet become sharply delimited, although they may be very distinct in their extreme forms. This state of things has caused the writer to adopt a very conservative view of the status of species in the genus *Sphaeralcea*. As every taxonomist knows, it is not easy to find a satisfactory criterion of what constitutes a species, or to adhere consistently to the criterion adopted. In general, however, an attempt has been made to follow, on the one hand, the principle stated by Payson (1918, p. 142) as follows: "Since, in the centers of their ranges [*Aquilegia*] *formosa* and *flavescens* are amply distinct, the author is very loath to treat one plant as a subspecies of the other. It would seem best to retain each as a species, never forgetting, however, that in certain regions the two actually merge." On the other hand, if two forms occupy substantially the same geographical area and are connected by numerous intergradations, it has seemed advisable to regard one as a subspecies of the other, even though there may be a rather large difference between the extremes.

Epharmonic variation, responsive to differences in the environment, is common, but many of the variations doubtless are genotypic, appearing in plants

growing side by side and persisting when they are transplanted. The great amount of variation in characters, such as those of the carpels, that are not supposed to be much affected by differences in the physical environment, also points to a prevalence of genotypic differences. In the writer's experience, where two species grow naturally in close proximity, seeds from plants of either species often produce plants of more or less intermediate character. This fact has been proved in a planting at Riverside, California, made for cytological and genetic study. On several occasions plants of markedly diverse character have been obtained from seeds of an individual that was growing near dissimilar individuals of the same, or another species. Only plants that, in their natural habitat, were well isolated from other forms have shown a strong tendency to "breed true."

There is reason to believe that in *Eusphaeralcea* there is a high degree of cross-compatibility between species that seem quite distinct morphologically. On the basis, presumably, of observations on plants cultivated in England, Sprague and Sandwith (1929) state that "the various species of *Sphaeralcea* hybridize readily." It is suspected, moreover, that certain forms which appear to be "good" and relatively stable species, may have originated "synthetically," as hybrids between two older species.[14]

It will be pointed out, in the discussion of anthesis and pollination, that fertilization seems to take place more readily with pollen of other individuals, even when these are of a different species, than with self-pollen. If this proves to be generally true in *Eusphaeralcea,* much of the variation within and intergradation between species with overlapping ranges may be attributed to hybridization. The writer hopes to obtain evidence on this point by appropriate breeding experiments, but considerable time must elapse before the results of such experiments will be available. In the meantime, indications afforded by observation in the field and by the examination of herbarium specimens may be considered.

The most abundant and widely distributed of the species occurring in southwestern Arizona are *ambigua* and *emoryi.* In their typical forms they are quite distinct, both morphologically and in habitat. *S. ambigua* occurs on rocky, well-drained hillsides, while *emoryi* is a plant of alluvial valleys, being especially common at roadsides and the edges of fields. Nevertheless, these species occasionally are found associated, especially where roads have been cut through the foothills, thus creating a habitat that is mutually congenial. In such places, typical examples of both species and a multitude of inter-

[14] A condition in the Tricolores subsection of the genus *Viola* similar to that which apparently exists in *Eusphaeralcea* is reported by J. Clausen (1931, p. 305), who states that it "gives the impression of being a young group still in full development, as its species are not yet delimited by the boundaries of intersterility." Zamelis (1931, p. 163) also found little correspondence in *Viola* between the species of taxonomists and genetic affinity as indicated by capacity for cross-fertilization. Anderson and Shafer (1931, p. 639) state that, in *Aquilegia,* "great morphological diversity between species is accompanied by unusual interfertility." The possibility of the origin of new species by hybridization has been considered by Lotsy in numerous papers, Clausen and Goodspeed (1925), Goodspeed and Clausen (1928), Jørgensen (1928), Babcock (1931), Winge (1932), Keck (1932), J. Clausen (1933), and others.

mediate forms are frequently found growing side by side (pls. 3 and 4). One may speculate whether the species *emoryi,* so nearly intermediate, in many of its characters, between *ambigua* and *angustifolia,* may not have originated as a hybrid between the two latter species.

No two species of the subgenus seem much more distinct than the annual *coulteri,* with orange or yellow petals, and the perennial *emoryi,* with a grenadine-colored corolla. The carpels of these species (pl. 9, *A, B*) are very unlike in size, shape, and relative development of the dehiscent part. Yet an individual that grew in southern Arizona, in close proximity to plants of these two species, resembled *emoryi* in its vegetative characters, inflorescence, and petal color, but was short-lived and had carpels that were nearly intermediate in all respects between those of the presumptive parental species (pl. 9, *C*).

Specimens in herbaria with intermediate characters, suggesting that they may have resulted from interspecies hybridization, are referred to in the descriptions of several of the species.

CYTOLOGY

AN INVESTIGATION of the cytology of *Eusphaeralcea* has been undertaken by the writer's colleague, J. M. Webber, who has determined the number of chromosomes in 13 species and 10 subspecies, representing 8 of the 12 sections distinguished by the writer. In all these forms, the chromosome number is $n = 5$ or a multiple thereof ($n = 10$, 15, or 25). Dr. Webber has found several instances of irregularity in the distribution of the chromosomes; and, in each instance of such irregularity, the characters of the plant indicated hybridization. But in the presumptive *coulteri* × *emoryi* F_1 referred to in the preceding section, the chromosome number was $n = 5$, the same as in *coulteri;* and no chromosomal aberrations were observed.

The cytological investigation has not yet reached a stage where conclusions may be drawn concerning the relation between the chromosome numbers and the taxonomy of this group. The data so far obtained do not indicate, however, that a close relation exists. In the annual or biennial Coulterianae the chromosome number is $n = 5$, but this number has been found, also, in several perennial species. Even within the limits of a single species, as defined by the writer on the basis of the gross morphology, Dr. Webber has found that different forms differ in the haploid number of chromosomes ($n = 10$, 15, and 25 in *emoryi;* 5, 10, and 15 in *ambigua*).

ECOLOGICAL NOTES

Habitat.—The North American species of *Eusphaeralcea* are confined to parts of the continent where precipitation is relatively limited. The species (*coccinea*) that ranges farthest eastward, extends little farther in that direction than meridian 95. Within the range of the subgenus, however, the species differ much in their preferences in respect to soil and exposure, and consequently exhibit various degrees of xerophilism.

Annuals like *coulteri,* on the one hand, which complete their development in the spring before the soil has dried out, are not, strictly speaking, xerophytic at all. On the other hand, some of the perennial species are markedly so. A notable example is *ambigua,* which, in its typical form, inhabits rocky slopes and sandy "washes," at elevations from sea level to about 2000 feet, where it is exposed to full sunlight (pl. 3). The plants often retain a few of their leaves during the driest months of the year. The xerophytic nature of this species is indicated by the character of the older leaves, which are thick, with veins very prominent beneath, and with margins folded and revolute. The dense canescence of the leaves and stems characterizing this species, and, indeed, most of the subgenus, also may be regarded as protective against excessive transpiration. The other extreme of habitat is represented among the perennial species by *fendleri,* which occurs usually at an elevation of 5000 feet or higher and prefers the partial shade of open pine forests. The writer has observed that, when this species grows at lower elevations and in more exposed situations, the plants are more pubescent.

These plants apparently are confined to soils having a basic reaction. One species, *laxa,* shows a marked preference for soils rich in lime, and is especially abundant on the "caliche" or lime hardpan soils in the vicinity of Tucson, Arizona. None of the species is, strictly speaking, halophilous, but *subhastata* and *coccinea* sometimes grow in moderately saline land. Most *Eusphaeralceae* prefer light, well-drained soils, but a few species, such as *subhastata* and *coccinea,* frequent plains where the soil is of fine texture and of relatively low permeability. Several species are now so largely confined to roadsides and the borders of cultivated fields, that one wonders what may have been the original habitat. This applies to *orcuttii, emoryi,* and the several forms of *angustifolia* in the United States, and to *coulteri californica* and *axillaris* in Lower California. The roads of southern Arizona are bordered almost continuously by the many-stemmed clumps of *emoryi,* which in the southwestern corner of the state give place to the tall, wand-like stalks of *orcuttii.*

In response to the two well-marked rainy seasons, winter and summer, that characterize southern Texas, New Mexico, and Arizona, the perennial species of *Sphaeralcea* in that region have two periods of flowering, spring and late summer, the summer flowering often extending well into the fall. The annual *coulteri* and the biennial *orcuttii* apparently flower only in spring.

Anthesis and pollination.—Observations in Arizona in April, on plants of *emoryi* and *ambigua,* have shown that the first opening of the corolla may occur at any time of the day, between about 9 A.M. and 4 P.M. Apparently only corollas that have opened for the first time late in the afternoon reopen the following morning. In the bud, the styles and stigmas are concealed by the mass of stamens, but become exserted soon after the corolla opens. For the most part, they remain erect or spreading during the day of anthesis but, after the petals begin to wilt and the anthers are practically empty of pollen, many of the styles become more or less reflexed. There is, however, no uniform recurving of the styles so as to bury the stigmas in the mass of stamens, such

as occurs in some of the Malvaceae. As the anthers begin to discharge pollen before the corolla opens, there must be ample opportunity for self-pollination at this stage.

Although the flowers of *Sphaeralcea* have very little odor, they are much visited by insects, especially small bees. At Sacaton, Arizona, in April, 1933, *Diadasia diminuta* Cresson was by far the most abundant visitor, but species of *Ammoplanus, Agapostemon, Calliopsis,* and *Halictus* also were taken.[15] A few honeybees were seen, working mostly on the outside of the corolla between it and the calyx, but occasionally entering the corolla. The nectaries at the bottom of the calyx (pl. 6, *C*) evidently were the attraction for the honeybees, but the Diadasia apparently were engaged mainly in collecting pollen. Owing to their activities, the anthers are emptied very soon after the corolla opens.

In spite of the apparently excellent adaptation for self-fertilization, the writer's colleague, George J. Harrison, was unsuccessful in obtaining seeds from flowers of several species of *Sphaeralcea* that had been enclosed in light cloth bags but not otherwise treated, although similarly enclosed flowers that had been emasculated in the bud and pollinated with pollen of another species produced a few seeds. Likewise, when an entire plant of *emoryi* was enclosed in a frame on which very light cheesecloth had been stretched, thus excluding pollinating insects, all the fruits dropped off before maturing, although, apparently, a few of the ovules in some of the fruits had been fertilized. A year previously the same plant, when not enclosed, had matured seeds in abundance. Three plants, of as many different species, planted singly at well-isolated stations near Riverside, California, set almost no fruit, although sister plants that were grown at Riverside in a mixed planting fruited abundantly. These facts indicate a strong tendency in this group to self-sterility.

Dissemination.—The highly specialized fruits of *Eusphaeralcea,* with carpels differentiated into an apical, dehiscent section and a basal, indehiscent section, each of which, in many of the species, contains a seed, is suggestive of an adaptation for dissemination under favorable conditions (pls. 9–12). The dehiscent portion discharges its seed as soon as the carpel matures, at which time soil conditions may not be favorable for germination and seedling development. In this circumstance, the seeds, even if their viability be of long duration, are exposed to destruction by various soil-inhabiting organisms. The indehiscent portion of the carpel, however, holds its seed until the tough, reticulate wall disintegrates, which may not occur until several weeks, or even months, .after maturity. In species with strong and persistent attaching strands (pl. 7, *A*) the carpels remain on the plants during this period. When they finally drop to the ground, there is a chance that better conditions of soil moisture may obtain than when the fruit matured. Probably, however, the beetles which frequently attack the fruits of *Eusphaeralcea* destroy a great many more of the basal than of the apical seeds. The writer's observation has

[15] These insects were identified by Miss Grace Sandhouse, through the courtesy of Dr. Harold Morrison, Bureau of Entomology, United States Department of Agriculture.

been that they confine themselves, in large measure, to the lower part of the fruit, tunneling through the adjacent walls until the entire circle of carpels has been riddled. The seeds borne in the upper, dehiscent, section of the carpels, it is likely, for the most part escape these ravages.[16]

Parasites.—C. J. King and Claude Hope have found that in southern Arizona at least one species, probably *emoryi,* is a host of the fungus, *Phymatotrichum omnivorum* (Shear) Dug., that causes the very destructive Texas root-rot disease of cotton. In both North America and South America, these plants are much infested by rust fungi. In North America, *Puccinia sherardiana* Koern. seems to be the most widely distributed geographically, and has been collected on 10 species of *Sphaeralcea.* Other species, apparently of rarer occurrence on plants of this genus, are *P. hibisciata* (Schw.) Kellerm., which sometimes attacks the cotton plant, *P. interveniens* (Peck) Bethel, *P. lobata* Berk. & Curt., *P. muhlenbergiae* A. & H., and *Sphaerella stenospora* E. & E.[17]

Insects that parasitize the fruits of Sphaeralcea and destroy large numbers of the seeds are of abundant occurrence. It is probable that much of the damage is done by weevils of the genus *Macrorhoptus.* Specimens taken by the writer in Arizona, in flowers and fruits of *emoryi,* were identified as *M. hispidus* Dietz by L. L. Buchanan, of the Bureau of Entomology, U. S. Department of Agriculture. Mr. Buchanan directed attention to published records and data on the labels of specimens that indicate the occurrence of *M. hispidus* throughout much of the range of the subgenus Eusphaeralcea in North America. Fasciation, probably resulting from insect injury, has been observed on several species in Arizona by the writer and his colleagues.

POPULAR INTEREST

THE IMPORTANCE of the North American Eusphaeralceae in human affairs is negligible, except for their limited value as cultivated ornamentals and the possibility that they harbor insects and diseases injurious to cotton and other economically important plants of the same family.

Labels of specimens in herbaria give vague indications of medicinal use, especially in Mexico, for such diverse purposes as a diuretic, in treatment of lockjaw, for promotion of the growth of hair, and for salving sores and wounds. The use of one species by the Hopi Indians as a remedy for diarrhea is mentioned by Fewkes (1896, p. 16). It is doubtful, however, that any of these plants are of real therapeutic value. The Hopi Indians are reported to use the stems of a species which they know as Kopóna as a substitute for chewing-gum (Hough, 1898, p. 143).

The writer is indebted to Miss Isabel Kelly, of the Department of Anthropology, University of California, for the information that the Southern Pai-

[16] Dehiscence of the carpels of *Eusphaeralcea,* in relation to dissemination, has been discussed by Hochreutiner (1919–22*a*, pp. 363–369).

[17] The writer is indebted to Dr. C. L. Shear and Miss Vera K. Charles, of the Bureau of Plant Industry, for these data on rust fungi.

ute Indians, of southern Utah, southern Nevada, and adjacent Arizona, occasionally eat the seeds of *S. parvifolia.* They are not, however, an important element of the diet.

Several species of *Eusphaeralcea* have been and may still be cultivated in European gardens, but their use as ornamentals always has been very limited, so far as the writer knows. The leaves are not especially attractive and, as the season advances, the plants become rather unsightly. The flowers, however, are showy and handsome. In early spring, a plant of *ambigua,* for example, with fifty or more stems each bearing a panicle of grenadine-colored flowers an inch or so in diameter, is a most attractive object. Species in which there is variation to other colors, such as *ambigua* and *emoryi,* make a really beautiful display when in full flower. There is a rather wide range of delicate tints that harmonize perfectly, and the silken, poppy-like texture of the petals enhances their beauty.

At least one species of the subgenus *Iliamna* (*S. remota*) is in cultivation in the eastern United States and it is probable that plants of this subgenus are better adapted to climatic conditions east of the Great Plains than are any of the Eusphaeralceae. Since the latter are natives of arid regions, it is doubtful whether they could be cultivated with much success in the eastern United States. But in the West, particularly in the region from central Texas to California, they should be a valuable acquisition to perennial borders, where their rather unattractive foliage could be partly masked by other plants. There are few native plants of that region that would adorn the garden with a greater wealth of color.

The name "globe mallow," evidently a literal translation of the scientific name of the genus, was used by Don (1831, p. 465) for species of *Sphaeralcea.* Apparently, no popular names have been applied to them in the United States except that, locally in Arizona, they are known as "Sore-Eye Poppies." This is probably a translation of "Mal de Ojos," a name by which these plants are known in Sonora. A name more widely used in Mexico, especially for *angustifolia,* is "Yerba del Negro," sometimes written "Hierba del Negro." Other Mexican names that appear on the labels of herbarium specimens are "Malva Loca del Monte," "Malva Cimarron," and "Flores de San José." P. C. Standley informed the writer that the last is a common name for the hollyhock in Central America.

CLASSIFICATION OF THE SUBGENUS

THE NORTH AMERICAN SPECIES of *Eusphaeralcea* are here arranged in twelve sections, of which several comprise only a single species and the largest five species. The endeavor has been to place in each section only species that evidently are closely related. The interrelationships of the sections, so far as they may be conjectured from morphological similarities and the occurrence of intermediate forms,[18] are reticular and cannot be represented by a linear arrangement. An attempt to indicate them graphically is presented in figure 1. The sections Emoryanae and Fendlerianae may be regarded as the most generalized groups, since each of them shows affinity with several other sections. The only section that shows no indication of relationship to any of the others is Endlichianae, although the sections Sulphureae and Lindheimerianae are, at most, very distantly related to any other. *S. endlichii,* as has been pointed out, is an anomalous form, scarcely belonging to this subgenus and apparently connecting *Eusphaeralcea* with the subgenus *Meliphlea.*

Many problems of relationship in the subgenus can be solved, if at all, only by experimental methods. The classification presented in this paper is admittedly provisional; but its publication seems warranted on grounds of convenience, in view of the utter confusion now prevailing in the taxonomy of the group. It is hoped that it may prove useful as a basis for future experimental work. Field studies, of course, have helped materially in determining the limits and relationships of the several forms. The writer regrets, therefore, that he has had opportunity to observe in the field only 18 of the 27 species and only 19 of the 29 subspecies described in this paper.

CITATION OF SPECIMENS AND ACKNOWLEDGMENTS

THE PLAN FOLLOWED in this paper is to cite all specimens of a species or subspecies that were examined, if the total number does not exceed 50. Of widely distributed species and subspecies that are represented very numerously in the large herbaria, it has seemed advisable to select specimens for citation. When this has been done, the word "Selected" appears in the paragraph heading "Specimens Examined." In making the selection, preference has been given to specimens bearing a collector's number and deposited in several of the large herbaria, but exceptions have been made of specimens showing aberrant characters or of importance in giving a more complete representation of the geographical distribution.

The capital letters, in parentheses, following the collector's name or number, indicate the herbaria in which the specimens cited are deposited. These are as follows: A, University of Arizona; B, Botanical Museum, Berlin-Dahlem; C, University of California; CA, California Academy of Sciences; F,

[18] In the present state of knowledge, it is usually impossible to determine whether inter-species hybridization rather than phylogenetic relationship may not be the cause of the occurrence of intermediate forms.

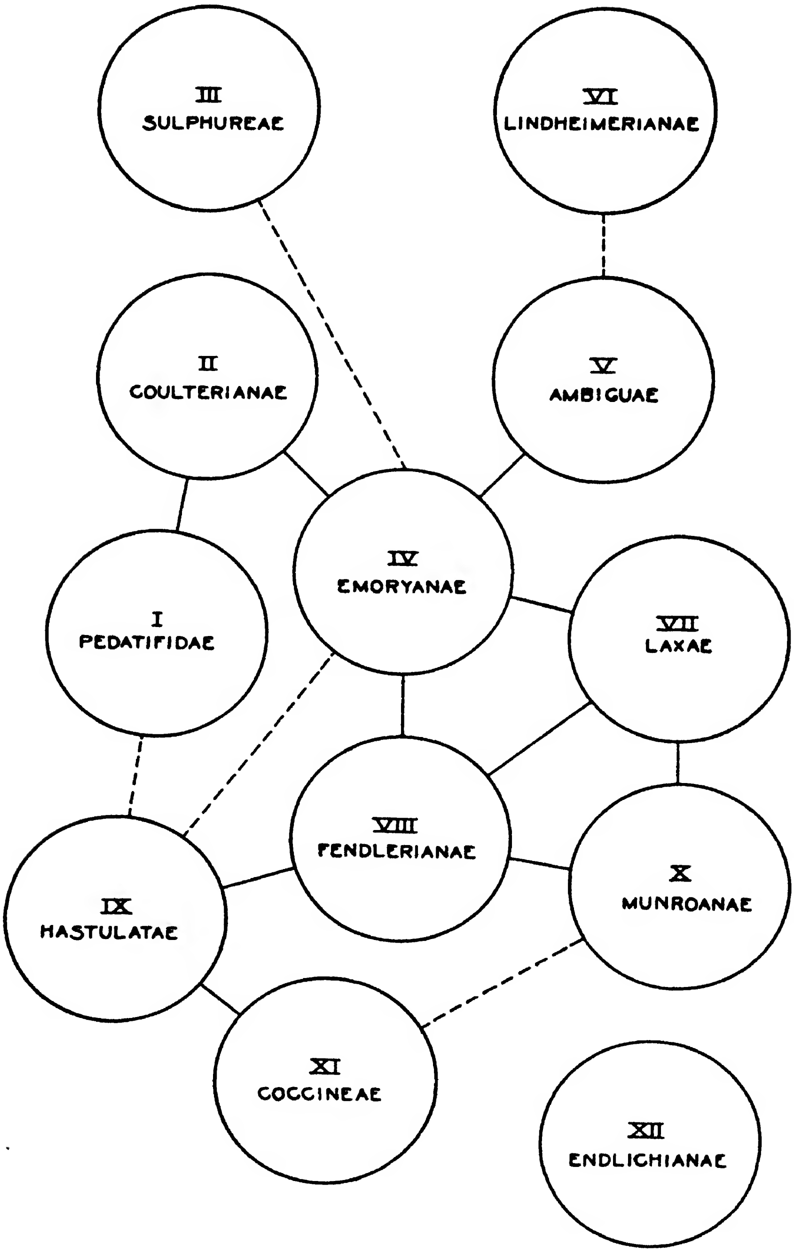

Fig. 1. Hypothetical relationships of the sections of *Eusphaeralcea*, as indicated by morphological similarities and the occurrence of intermediate forms. No attempt has been made to indicate relative closeness of relationship, except that where the indication of affinity seems exceptionally faint a broken instead of a solid connecting line is used.

Field Museum; G, Gray Herbarium, Harvard University; J, Jepson Herbarium; M, Missouri Botanical Garden; N, U. S. National Herbarium; NM, New Mexico State College; P, Pomona College; R, Rocky Mountain Herbarium, University of Wyoming; S, Stanford University; Sac, Herbarium of the U. S. Field Station, Sacaton, Arizona; Y, New York Botanical Garden.

For the privilege of examining material in the several herbaria, the writer is under great obligation to the heads of the respective departments of botany and the curators. The photographs from which the illustrations were prepared were made by Robert L. Taylor, of the Bureau of Plant Industry, United States Department of Agriculture, with the exception of plates 3 and 4, photographed by Claude Hope, of the same organization. Valuable assistance in the field studies was rendered by George J. Harrison, A. R. Leding, and R. H. Peebles, also of the Bureau of Plant Industry. Helpful suggestions in the preparation of the manuscript were given by W. R. Maxon, of the Smithsonian Institution, and S. F. Blake, of the Bureau of Plant Industry. To E. P. Killip, of the Smithsonian Institution, the writer is indebted for photographs of type specimens in European herbaria.

SUBGENUS EUSPHAERALCEA

Key to the Sections

Carpels dehiscent to the base dorsally and very nearly so ventrally, not reticulate or very faintly so near the base. . . . . XII. Endlichianae.

Carpels not dehiscent below the notch, the indehiscent part reticulate, usually conspicuously so.

- Indehiscent, reticulate part of the carpel conspicuously wider than the dehiscent part, forming ⅔ or more of the carpel.
  - Adult leaves only shallowly lobed, rarely deeply cleft.
    - Annual or biennial; petals orange; carpels 1 to 3 mm. high, with scarious walls. II. Coulterianae.
    - Perennial; petals red (grenadine); carpels 3 to 5 mm. high, with chartaceous walls. IX. Hastulatae (*S. hastulata*).
  - Adult leaves, at least the lower ones, 3-parted or 3-divided.
    - Plant sparsely pubescent; carpels 15 or more, with thin, chartaceous walls, very deeply notched. I. Pedatifidae.
    - Plant canescent or lepidote; carpels fewer than 15, with thick, coriaceous walls, not very deeply notched. . . . . XI. Coccineae.
- Indehiscent, reticulate part of the carpel not conspicuously wider than the dehiscent part, forming less than ⅔ of the carpel.[19]
  - Petals not more than ½ as wide as long, with long, narrow claws, yellowish. III. Sulphureae.
  - Petals considerably more than ½ as wide as long, with short, broad claws, not yellow.
    - Stems and leaves copiously pubescent with relatively very long, soft, felted hairs, those of the stem 1.0 to 1.5 mm. long. . . . . . . VI. Lindheimerianae.
    - Stems and leaves sparsely pubescent to canescent or tomentose with relatively short hairs, those of the stem less (usually much less) than 1.0 mm. long.

[19] Forming, exceptionally, as much as ⅔ in *S. axillaris violacea* (Section Emoryanae).

Carpels with very thin, almost scarious walls, areolae of the reticulate part transparent.
 Inflorescence a narrow, interrupted, many-flowered thyrse. . IV. EMORYANAE.
 Inflorescence an open, relatively few-flowered panicle. . . . . VII. LAXAE.
Carpels with thicker, chartaceous walls, areolae often nearly opaque.
 Indehiscent part of the carpel usually rugose or muricate dorsally, reticulations prominent and usually coarse.
  Fruit hemispherical or nearly so; carpels usually muticous or mucronulate, conspicuously galeate, ⅗ to ¾ as wide as high. . . . V. AMBIGUAE.
  Fruit truncate-conical; carpels usually cuspidate, not conspicuously galeate.
   Pedicels usually persistent; inflorescence a many-flowered thyrse; stems seldom less than 60 cm. long. . . . . IV. EMORYANAE.
   Pedicels detaching promptly at maturity of the fruit; inflorescence racemiform or subthyrsoid; stems not more than 50 cm. long. IX. HASTULATAE.
 Indehiscent part of the carpel smooth or nearly so dorsally, reticulations usually fine and not very prominent.
  Inflorescence relatively few-flowered, an open, long-branched panicle or narrower and subthyrsoid; carpels about ½ as wide as high. VII. LAXAE.
  Inflorescence many-flowered, thyrsoid-glomerate (or, if few-flowered and racemiform, the carpels much more than ½ as wide as high).
   Carpels ½ to ⅗ as wide as high; fruit truncate-conical.
    Leaf blades about as long as wide, shallowly lobed, usually cordate; pubescence grayish or whitish. . . . . . . X. MUNROANAE.
    Leaf blades much longer than wide (or, if not much longer, either pedate, or cuneate at base, or the pubescence yellowish). VIII. FENDLERIANAE.
   Carpels ⅗ to fully as wide as high; fruit hemispherical or slightly higher. X. MUNROANAE.

KEY TO THE SPECIES AND SUBSPECIES

I. PEDATIFIDAE.

One species. . . . . 1. **pedatifida.**

II. COULTERIANAE.

Plant densely yellowish-canescent, appearing scurfy; leaf blades thick and firm; carpels 2.5 to 3.0 mm. high, rather deeply notched. . . . . 2. **orcuttii.**

Plant grayish pubescent, often sparsely so; leaf blades thin and soft; carpels 1.2 to 2.5 mm. high, shallowly notched.
 Leaf blades about as wide as long, usually obtuse at apex, more or less cordate at base, coarsely crenate, often distinctly 3-lobed. . . . . 3. **coulteri (typica).**
 Leaf blades usually longer than wide, acute or acutish at apex, usually subcuneate or truncate at base, very shallowly lobed or angulate.
  Inflorescence a compound, many-flowered panicle; leaf blades finely crenate or crenulate. . . . . 3a. **coulteri californica.**
  Inflorescence a few-flowered, open panicle; leaf blades rather coarsely crenate-dentate. 3b. **coulteri margaritae.**

III. SULPHUREAE.

Plant whitish-canescent or tomentose; stems terete or nearly so; leaf blades with veins not very prominent beneath, subcordate to subcuneate; calyx not conspicuously ribbed; carpels about 12. . . . . 4. **sulphurea.**
Plant yellowish-canescent; stems conspicuously angled; leaf blades with veins very prominent beneath, strongly cuneate; calyx conspicuously ribbed; carpels about 17. 5. **palmeri.**

IV. Emoryanae.

Indehiscent part of the carpel considerably narrower than the dehiscent part, finely reticulate.
Larger leaf blades 6 to 10 cm. long, usually considerably longer than wide; carpels often connate at maturity; seeds copiously pubescent. . . . . 7. **hainesii.**
Larger leaf blades 3 to 5 cm. long, not or but slightly longer than wide; carpels not connate at maturity; seeds glabrous or nearly so. . . . . 8c. **emoryi arida.**
Indehiscent part of the carpel about as wide as the dehiscent part.
Carpels with scarious walls, the indehiscent part finely reticulate.
Petals white or pink, drying yellowish, lavender, or violet.
Carpels 4 mm. high, about ½ as wide, narrowed to an obtuse apex, usually mucronate or cuspidate. . . . . 6. **axillaris (typica).**
Carpels 2 to 3 mm. high, ⅔ as wide or wider, broad and rounded at apex, usually muticous. 6a. **axillaris violacea.**
Petals grenadine, not changing color appreciably in drying.
Leaf blades not less than ¾ as wide as long. . . . . 8c. **emoryi arida.**
Leaf blades not more than ½ as wide as long. . . . . . 8b. **emoryi nevadensis.**
Carpels with chartaceous walls, the indehiscent part rather coarsely reticulate.
Leaf blades merely angulate or toothed near the base, thickish. . 8. **emoryi (typica).**
Leaf blades distinctly lobed or parted, often thin. . . . . 8a. **emoryi variabilis.**

V. Ambiguae.

Leaf blades longer than wide, usually subcuneate and lobed near the base; inflorescence a long, narrow, interrupted, many-flowered thyrse. . . . . 9. **fulva.**
Leaf blades approximately as wide as long, subcordate to deeply cordate, lobed near the middle; inflorescence an open panicle (or, if racemiform or thyrsoid, usually few-flowered).
Pubescence of leaves conspicuously varicolored, yellowish above, white beneath, orange-yellow on the margin. . . . . 10d. **ambigua versicolor.**
Pubescence of leaves not conspicuously varicolored.
Stems usually suffrutescent above the crown and more than 50 cm. long; inflorescence usually an open, long-branched panicle.
Petals grenadine. . . . . 10. **ambigua (typica).**
Petals pink or lavender, often drying violet. . . . . . 10a. **ambigua rosacea.**
Stems usually herbaceous above the crown and less than 50 cm. long; inflorescence racemiform or narrowly thyrsoid.
Carpels usually coarsely reticulate; pubescence of stems usually whitish; leaf blades often thin and not conspicuously rugose-veined. . 10b. **ambigua monticola.**
Carpels usually finely reticulate; pubescence of stems yellowish; leaf blades thick, conspicuously rugose-veined. . . . . 10c. **ambigua rugosa.**

VI. Lindheimerianae.

One species. . . . . 11. **lindheimeri.**

VII. Laxae.

Calyx not conspicuously more pubescent than the stems and leaves, these usually densely whitish-canescent or tomentose; carpels with scarious walls, usually acutish and cuspidate, rather prominently reticulate. . . . . 12. **laxa.**
Calyx conspicuously more pubescent than the stems and leaves, these usually green and glabrescent; carpels with chartaceous walls, usually very obtuse and muticous or mucronate, often rather faintly reticulate.

Calyx lobes 1 to 2½ times as long as the tube; fruit not less than ⅔ as high as the calyx.
Leaf lobes narrow, the mid-lobe not more than 3 mm. wide at base. 13. **rusbyi (typica).**
Leaf lobes wider, the mid-lobe usually not less than 5 mm. wide at base. 13a. **rusbyi gilensis.**
Calyx lobes about 3 times as long as the tube; fruit about ½ as high as the calyx. 13b. **rusbyi eremicola.**

VIII. FENDLERIANAE.

Leaf blades pedately cleft or parted. . . . . 14. **wrightii.**
Leaf blades not pedate, although sometimes deeply cleft.
Blades usually more than ½ as wide as long (or, if narrower, pubescence yellowish, very short, scurfy, or sparse and the leaf blades thin).
Pubescence yellowish (or, if whitish, leaf blades more or less cordate at base); blades shallowly lobed with usually broad, rounded lobes; petals 10–17 mm. long; column 6–8 mm. long; hairs of the stem very short (0.1–0.2 mm.), many-rayed.
Petioles ½ as long as the blade or longer; blades ⅔ as wide to wider than long, usually subcordate or truncate at base, cleft usually near the middle. 15. **incana (typica).**
Petioles usually less than ½ as long as the blade; blades ⅓–⅔ as wide as long, cuneate at base, cleft usually near the base. . . . . . 15a. **incana cuneata.**
Pubescence grayish or whitish; leaf blades often deeply cleft with the lateral lobes usually triangular and acutish; petals 8–13 mm. long; column 4–6 mm. long (or, if petals and column longer, hairs of the stem 0.6–0.8 mm. long, few-rayed).
Hairs of stem 0.6–0.8 mm. long, 4-8–rayed; petals 15–20 mm. long, usually pink, drying lavender or violet. . . . . 16d. **fendleri venusta.**
Hairs of stem not more than 0.4 mm. long, 10-18–rayed; petals less than 15 mm. long, usually grenadine.
Plant whitish-velutinous, especially the lower leaf-surface. 16b. **fendleri albescens.**
Plant green or grayish, not velutinous.
Lateral leaf-lobes ½–⅔ as long as the mid-lobe, spreading, very obtuse, margin nearly entire. . . . . 16c. **fendleri tripartita.**
Lateral leaf-lobes usually less than ½ as long as the mid-lobe, usually ascending and acutish, margin crenate or dentate.
Leaf blades thin and rather sparsely pubescent, 5–9 cm. long, usually less than ½ as wide, very shallowly lobed. . . . 16a. **fendleri elongata.**
Leaf blades usually thickish and copiously pubescent, 3–6 cm. long, usually more than ½ as wide, often deeply cleft. . . . 16. **fendleri (typica).**
Blades usually much less than ½ as wide as long, thickish, copiously grayish-pubescent.
Petals usually pink or lavender; carpels usually obtuse, muticous or mucronulate; leaf blades only angulate or obscurely toothed near the base. 17. **angustifolia (typica).**
Petals usually grenadine; carpels usually acutish, mucronate or cuspidate; leaf blades distinctly toothed or short-lobed near the base.
Blades not more than ⅓ as wide as long, with subhastate teeth usually less than 1/10 as long as the mid-lobe. . . . . 17a. **angustifolia cuspidata.**
Blades ⅓–½ as wide as long, with subhastate lobes 1/10–⅕ as long as the mid-lobe. 17b. **angustifolia lobata.**

IX. HASTULATAE.

Pubescence of the lower leaf-surface conspicuously different from that of the upper surface, whitish, sericeous; indehiscent part more than ½ of the carpel, usually conspicuously wider than the dehiscent part. . . . . 18. **hastulata.**
Pubescence of the lower leaf-surface denser but not otherwise conspicuously different from that of the upper surface; indehiscent part not more than ½ of the carpel.

Calyx lobes usually deltoid, acute, about equaling the fruit; carpels ⅗–¾ as wide as high; leaf blades deeply cleft to almost divided, the lateral divisions at least ⅓ as long as the mid-lobe. . . . . 19e. **subhastata pumila.**

Calyx lobes usually lanceolate, acuminate, conspicuously surpassing the fruit; carpels ½–⅗ as wide as high.

Inflorescence usually subthyrsoid to the apex, with 2 or 3 flowers at most of the nodes; leaf blades deeply cleft to almost divided, the lateral lobes or divisions usually ¼ as long as the mid-lobe or longer. . . . . . . 19d. **subhastata thyrsoidea.**

Inflorescence racemiform, or subthyrsoid below; leaf blades subhastately angled or toothed (or, if more deeply cleft, the lateral lobes usually less than ¼ as long as the mid-lobe).

Leaf blades obtuse, with broad, obtuse lobes and teeth. . 19c. **subhastata latifolia.**

Leaf blades acutish to acuminate, with usually acutish lobes and teeth.

Plant whitish-canescent or subtomentose; petioles often nearly equaling the blade; inflorescence leafy only at base; pedicels often equaling or surpassing the calyx. . . . . 19b. **subhastata martii.**

Plant green or grayish-canescent; petioles usually much shorter than the blade; inflorescence more or less leafy throughout; pedicels often shorter than the calyx.

Carpels at maturity usually strongly connate and not separable without tearing; leaf blades usually about ½ as wide as long. 19a. **subhastata connata.**

Carpels at maturity free or nearly so; leaf blades usually less than ½ as wide as long. . . . . 19. **subhastata (typica).**

X. Munroanae.

Leaf blades not pedate, nor cleft more than ½ way to the midvein, usually shallowly lobed.

Calyx lobes nearly thrice the length of the tube; plant densely soft-pubescent; stems 10–20 cm. long; inflorescence racemiform, few-flowered. . . . . 20. **caespitosa.**

Calyx lobes not more than twice the length of the tube; plant canescent; stems usually much more than 20 cm. long; inflorescence thyrsoid-glomerate, many-flowered.

Pubescence dense, grayish; leaf blades usually thickish and crenulate or finely crenate; carpels broadly ovate, usually acutish and mucronate or cuspidate. 21. **parvifolia.**

Pubescence usually sparse and plant bright green; leaf blades usually thin and coarsely dentate or crenate; carpels nearly orbicular, very obtuse, muticous or mucronulate. 22. **munroana (typica).**

Leaf blades pedate or cleft more than ½ way to the midvein.

Inflorescence a narrow, interrupted, many-flowered thyrse.

Carpels nearly orbicular, very obtuse, muticous or mucronulate, 1-seeded.

Plant bright green, sparsely pubescent; leaf blades usually strongly cuneate. 22a. **munroana subrhomboidea.**

Plant whitish- or grayish-canescent; leaf blades usually more or less cordate. 23. **grossulariaefolia (typica).**

Carpels broadly ovate, usually acutish and mucronate or short-cuspidate, often 2-seeded. . . . . 23a. **grossulariaefolia pedata.**

Inflorescence racemiform or subthyrsoid, few-flowered; carpels broadly ovate, acutish, usually mucronate or short-cuspidate.

Pedicels mostly rather stout and shorter than the calyx; inflorescence usually with 2 or 3 flowers at some of the lower nodes. . . . . . . 24. **digitata (typica).**

Pedicels mostly slender and longer than the calyx; inflorescence usually with only 1 flower at each node. . . . . 24a. **digitata tenuipes.**

XI. Coccineae.

Stems and leaves silvery-lepidote; upper leaf-blades entire, the lower ones 3-divided or nearly so; calyx closely lepidote; carpels 7–9. . . . . 25. **leptophylla.**

Stems and leaves canescent or more coarsely pubescent; all leaf blades deeply cleft, parted or divided; calyx villous; carpels 10–14.

Primary lateral divisions of the leaf blade less than ⅝ as long as the mid-lobe; dehiscent part of the carpel usually ascending, deltoid, acutish, forming about ⅛ of the whole. . . . . 26b. **coccinea elata.**

Primary lateral divisions of the leaf blade at least ⅝ as long as the mid-lobe; dehiscent part of the carpel usually horizontal, irregularly quadrangular, forming less than ⅛ of the whole.

Plant usually conspicuously and densely whitish-pubescent; leaf blades with very narrow divisions. . . . . 26a. **coccinea dissecta.**

Plant usually green and less densely pubescent; leaf blades with relatively broad divisions. . . . . 26. **coccinea (typica).**

XII. Endlichianae.

One species. . . . . 27. **endlichii.**

DESCRIPTIONS OF THE SPECIES AND SUBSPECIES*

1. **Sphaeralcea pedatifida** Gray, Proc. Am. Acad., 22:291. 1887.

Malvastrum pedatifidum Gray, Boston Jour. Nat. Hist., 6:160. 1850.

Sidalcea atacosa Buckley, Proc. Acad. Phila., 13:449. 1862.

Plant probably biennial or a short-lived perennial, herbaceous throughout, with a slender taproot and small crown, green, sparsely to somewhat copiously pubescent with long, rather stiff, mostly appressed, few-rayed hairs, those of the stem 0.5–0.8 (rarely 1.4) mm. long, with 5–8 rays. Stems few, slender, decumbent or ascending, up to 70 cm. long but usually much shorter, up to 3 mm. in diameter at base but usually smaller. Leaf blades thin, mostly 5-veined from the base, pedately parted (almost divided), all the divisions pinnately cleft or coarsely toothed with acute or acutish, often setose-tipped teeth, the mid-lobe 1½–2 times the length of the lateral lobes, the larger blades 1.5–3 cm. long and at least equally wide. Petioles slender, somewhat shorter to considerably longer than the blade. Inflorescence few-flowered, racemiform, or occasionally subthyrsoid below. Pedicels slender, shorter than to more than twice as long as the calyx. Bractlets of the involucel often denticulate, often persistent until maturity of the fruit. Calyx at anthesis 6–9 mm. high, with ovate-lanceolate or deltoid, more or less acuminate lobes 1½–3 (usually 2) times as long as the tube. Petals orange-chrome or grenadine-pink, 8–14 mm. long. Column glabrous or sparsely pubescent. Fruit hemispherical or flatter, less than ½ to ¾ as high as the calyx. Carpels (pl. 9, *E*) 15–20, with thin chartaceous walls, 3–3.5 mm. high and ⅔ to very nearly as wide, very deeply notched, the depth of the notch equaling or exceeding the width of the carpel at that point, the dehiscent portion usually erect, irregularly quadrangular or nearly triangular with a very prominent ventral beak, muticous, the

* A South American species, *Sphaeralcea miniata* (Cav.) Spach, has been collected, in several forms, on ballast ground at seaports on the Atlantic coast of the United States (Camden, N. J., Charleston, S. C.) and on wool waste at mill towns in Massachusetts (Westford, Auburn, Millbury), but apparently has not become established anywhere in North America. One of these forms, subsp. *cisplatina* K. Schum. (*S. cisplatina* St. Hil.), is the type of the genus. A representative carpel is shown in plate 12, *L*, and the resemblance to the carpels of some of the North American species is evident.

indehiscent portion forming ⅔–¾ of the carpel, wider (usually much wider) than the dehiscent portion, coarsely and prominently reticulate, fenestrate, nigrescent, rugose-tuberculate or muricate dorsally; attaching threads very delicate and fragile, sometimes apparently wanting. Ovule and seed 1. Seeds sparsely pubescent or nearly glabrous.

Type locality.—"On the Rio Grande, Texas, in dry soil." Type (G?) collected by C. Wright in 1848.

Geographical distribution and habitat.—Southern Texas and northern Coahuila at elevations only a few hundred feet above sea level. Grows in sandy soil, often near streams.

Specimens examined.—TEXAS. Hays County: Kyle, *Letterman* 5516 (Y). Bexar County: San Antonio, *Letterman* 103 (M), in 1882 (G, N, Y). Atascosa County: *Schulz* 462 (N). Pleasanton, *E. J. Palmer* 9765 (M, N, S). Dimmit County: Carrizo Springs, *Jones* 28244 (C), without number (M), *E. J. Palmer* 33754 (Y). Winterhaven, *Jones* 29378 (C, M). Maverick County: Eagle Pass, *Hanson* 28A (M, N), in 1919 (G, Y), *Havard* (N). Quemado, *Kearney and Harrison* 9 (N). Kleberg County: Kingsville, *High* 53 (M), *Lewton* 191 (N). Jim Wells County: Alice, *E. J. Palmer* 11261a (C, M, R). Premont, *Drushel* in 1929 (N). Duval County: San Diego, *Clark* 4036 (M), *Crofts* 123 (Y), 1153 (M). Webb County: Laredo, *Eggert* in 1901 (G, M), *Mackenzie* 58 (M, N, Y), *Reverchon* 3819 (G, M, N, P, Y), *Rose* 11014 (N, Y). Jim Hogg County: Hebronville, *Hanson* 28A[20] (N). Starr County: Rio Grande City, *Nealley* 36 (F), *Runyon* 142 (N), 842 (N). (?) County: Rio Bravo del Norte, *Schott* (Y). Rio Grande, *Wright* in 1848, probably the type collection (G). Willett, *Trelease* (M).

COAHUILA. Diaz, *Rose and Hay* 5256 (N).

A well-marked and relatively constant species, easily distinguished by the character of the pubescence, pedate leaves, exceptional persistence of the involucel, and shape of the carpels. *S. rusbyi,* of central and northern Arizona and adjacent Utah, is somewhat similar in its sparse pubescence of few-rayed hairs and in the shape of the leaf blades, but is a long-lived perennial, with a well-developed, woody crown, and has entirely different carpels (pl. 9, *E*, pl. 10, *G*). *S. pedatifida* has been much confused with *S. digitata* (Greene) Rydb., a wholly different plant (pl. 12, *E, F*). To judge from the slender taproot and absence of woodiness, *pedatifida* would seem to be, at most, biennial, but the writer is informed by Professor B. C. Tharp, of the University of Texas, that it is perennial. The weak stems are often supported by other vegetation. The calyx is connivent after anthesis, but widespreading at maturity of the fruit.

Plants seen by the writer near Eagle Pass, Texas, in September, had petals of an orange-chrome color, as in *S. coulteri* (Wats.) Gray, but George J. Harrison states that, in the same locality, the petals were redder in early spring. This resemblance in petal color, together with the probable short life of the plant and the characters of the carpels (pl. 9, *E*; pl. 9, *A, F*) indicate a distant relationship to the Coulterianae, although the leaf shape and pubescence are very different. The resemblance in the shape of the carpels of *pedatifida* to those of *S. hastulata* Gray (pl. 9, *E;* pl. 11, *F*) suggests the possibility of a relationship between these otherwise very different plants.

[20] Other specimens bearing the same number are labeled as from Eagle Pass.

2. Sphaeralcea orcuttii Rose, Contr. U. S. Nat. Herb., 1:289. 1893.

Plant annual or biennial with a large taproot, very densely yellowish canescent with short hairs, those of the stem 0.2–0.3 mm. long, with 12–20 rays. Stems erect, tall (up to 120 cm. long) and stout (up to 10 mm. in diameter at base). Leaf blades thick and firm with veins prominent beneath, deltoid-ovate, at base usually subcordate, at apex obtuse or acutish, 3- to 5-veined from the base, shallowly (usually very shallowly) 3-lobed near the base with rounded lobes, margin crenulate and sometimes rugose, the larger blades 3–5.5 cm. long and 3/5–4/5 as wide. Petioles rather stout, usually about 1/2 as long as the blade. Inflorescence long, narrow, many-flowered, glomerate-thyrsoid, the lower branches often elongate (up to 10 cm.) and racemosely flowered. Pedicels shorter to somewhat longer than the fruiting calyx. Calyx at anthesis 4–7 mm. high, less than 1/2 as high as the corolla, with deltoid or ovate-lanceolate, acuminate lobes 2–3 times as long as the tube, closely connivent after anthesis. Petals flame-scarlet or bittersweet orange, 8–12 mm. long. Stamens relatively few, aggregated at the summit of the sparsely pubescent column. Fruit hemispherical, usually about 2/3 as high as the calyx. Carpels (pl. 9, *F*) 12–17, with very thin, scarious walls, 2.5–3 mm. high and 3/4 to equally wide, reniform, rather deeply notched, the dehiscent portion ascending, irregularly quadrangular to subdeltoid, truncate or rounded at apex, muticous, the indehiscent portion forming 3/4–4/5 of the carpel, much wider than the dehiscent portion, prominently reticulate, fenestrate, nigrescent; attaching threads long, delicate, and fragile. Ovules and seeds usually 1, but sometimes 2. Seeds pubescent, usually sparsely so.

Type locality.—Carriso Creek, Colorado Desert, Imperial or San Diego County, California. Type (N) collected by C. R. Orcutt, November 1, 1890, No. 2210.

Geographical distribution and habitat.—Southwestern Arizona and northwestern Sonora to southeastern California (Colorado Desert) and middle Lower California, ascending to, at most, a few hundred feet above sea level. Inhabits roadsides and fields, usually in sand but sometimes in soils of heavier texture.

Specimens examined.—ARIZONA. Yuma County: Dome, *Peebles and Harrison* 5043 (N). Mohawk to Wellton, *Kearney* 3935 (N), *Harrison and Kearney* 6557 (CA, Y), 8405 (N, Y), 9143 (N). Yuma, *Harrison and Kearney* 6591 (CA, N, Y), *Peebles, Harrison, and Kearney* 4938 (N), *Wolf* 2288 (CA, G, S). Colorado River bottoms, *Schott* 2, in part (F).

CALIFORNIA. Imperial County: Brawley, *Applegate* 3324 (C, F), *Munz* 11936 (C, F, N, P). Calexico, *Abrams* 4002a (F, G, M, P, S, Y), *Davy* 7953 (C), *Holmes* in 1901 (N). Coyote Wells, *Spencer* 456 (G, N, P, Y). Dixieland, *Munz* 7817 (G, P), *Parish* 9020 (S). Heber, *Abrams* 4095 (G, M, P, S, Y). Holtville, *Munz* 11945 (C, F, N, P). Imperial, *Brandegee* in 1901 (C), *Wooton* in 1912 (N). Meloland, *McGregor* 2016 (S), *Parish* 8097 (C, G, S). Signal Mountain, *Brandegee* in 1901 (C). Westmoreland, *Campbell* 15 (CA), *McGregor* 817 (S), *Meyer* 415 (C), *Wolf* 1869 (C). Imperial (or San Diego) County: Colorado Desert, *Emory* in 1846 (Y). Carriso Creek, *Orcutt* 2210, the type collection (G, N).

SONORA. El Capitan, *Lumholtz* 23 (G).

LOWER CALIFORNIA. Cocopah Mountains, *Macdougal* 205 (Y). Indian Wells, *Orcutt* 2042 (C, N). Laguna Maquata, *Eppling* et al., in 1933 (F). San Bertolomé Bay, *Rose* 16215 (N, Y). San Ignacio (north of), *Reed* 6167 (P).

This well-marked species rather strikingly resembles *S. incana* Torr. in general appearance and in the character of the pubescence, but *incana* is per-

ennial and has very different carpels (pl. 10, *I*). The carpels of *orcuttii* (pl. 9, *F*) are usually 1-ovuled and 1-seeded, but in two specimens occasional carpels contained two seeds. One of these (*Holmes*, Calexico, Calif.) was typical otherwise, but the other (*Rose* 16215, San Bertolomé Bay, Lower California) was aberrant in its relatively long and narrow leaves, relatively high and narrowly lobed calyx, and thicker carpels, with a relatively small indehiscent portion, forming only 3/5–2/3 of the carpel. Rose's specimen was collected at the southern extremity of the known range of *orcuttii* and within the range of *S. fulva* Greene, which it somewhat resembles superficially, although differing in its fine, close pubescence and in the characters of its carpels. A specimen collected in Lower California by Purpus (C), without definite locality, resembles *fulva* in its relatively coarse pubescence and relatively long, narrow, and deeply lobed leaves, but has typical *orcuttii* carpels. A small-flowered form, with petals only about 4 mm. long, was found near Wellton, Arizona (*Harrison and Kearney* 9143).

3. **Sphaeralcea coulteri** (Watson) Gray, Proc. Am. Acad., 22:291. 1887.
Malvastrum coulteri Watson, Proc. Am. Acad., 11:125. 1876.

Plant annual, with a slender taproot, green or grayish, usually sparsely and never very densely pubescent with rather long, soft hairs, those of the stem 0.4–0.8 mm. long, with 8–14 rays. Stems erect, up to 150 cm. long, but usually much shorter, up to 4 mm. in diameter at base, but usually much more slender. Leaf blades thin and soft, broadly ovate to nearly orbicular, at base truncate to cordate, at apex very obtuse to acutish, 5-veined from the base, scarcely lobed to rather deeply 3- to 5-lobed with rounded lobes, coarsely crenate, the larger ones 1.5–3 cm. long, nearly as wide as to somewhat wider than long. Petioles slender. Inflorescence thyrsoid, few- to many-flowered, the lower branches sometimes elongate. Pedicels slender, shorter than to twice as long as the fruiting calyx. Calyx at anthesis 5–7 mm. high, with lanceolate or ovate-lanceolate, attenuate-acuminate lobes 2–3 times as long as the tube. Petals orange-chrome or salmon-orange, 8–15 mm. long. Stamens relatively few, aggregated near the summit of the conspicuously pubescent column. Fruit hemispherical or flatter, 1/3–2/5 as high as the calyx. Carpels (pl. 9, *A*) 14–22, with very thin, scarious walls, 1.8–2.5 mm. high and 4/5–6/5 as wide, reniform, shallowly and narrowly notched, the dehiscent part horizontal or ascending, irregularly quadrangular, truncate or rounded at apex, muticous, the indehiscent part forming 2/3–3/4 of the carpel, much wider than the dehiscent part, prominently reticulate, fenestrate, nigrescent; attaching threads delicate, fragile. Ovule and seed 1. Seeds glabrous or sparsely pubescent.

Type locality.—"Probably in southeastern California" (Watson); western Arizona (Gray). Type (G) collected by Thomas Coulter, No. 96.

Geographical distribution and habitat.—Southwestern Arizona and southeastern California to Sinaloa, ascending to about 2500 feet above sea level. Inhabits roadsides, fields, and mesas, usually in sandy soil.

Specimens examined.—ARIZONA. Pinal County: Casa Grande, *Eastwood* 8051 (CA), *Griffiths* 4013 (M, N). Florence, *Toumey* 82 (N, S), *Fulton* 7679 (Y). Maricopa, *Gray* in 1885 (G). Sacaton, *Peebles* 3645 (N), *Peebles and Harrison* 1734 (N). Maricopa County: Agua Caliente, *Carlson* in 1914 (CA, N). Glendale, *Eastwood* 6122 (CA, N). Hot Springs Junction, *Peebles and Kearney* 6808 (N). Phoenix, *Abrams* in 1929 (S). Salt River Mountains, *Gillespie* 8848 (C, G, Y). Scottsdale, *Gillespie* 5631 (C, N). Tempe, *Abrams*

13044 (S), *Ganong and Blaschka* in 1892 (G), *Griffiths* 4320 (N). Pima County: Growler Mountains, *Wiggins* 6539 (S). Pacinano, *Thackery* 177A (N). Quitobaquito, *Mearns* 2774 (G, S). Yuma County: Yuma, *Eastwood* 6335 (CA), *Jones* in 1906 (CA, N, P, S, Y). Yuma(?) County: *Coulter* 96 (G), the type collection.[21] Gila River bottoms, *Schott* 855 (G, Y). Gila River, *Antisell* 31 (Y).

CALIFORNIA. Imperial County: Bard, *Kearney* in 1935 (N).

SONORA. Altar, *Long* 35 (N). Guaymas, *Palmer* 171 (CA, F, G, N). Hermosillo, *Brandegee* in 1892 (C), *Rose, Standley, and Russell* 12393 (N, Y). Hermosillo to Torres, *Wiggins* 6263 (S). Magdalena, *Kennedy* 7058 (C, CA, N, P), 7059 (CA, N). Navajoa, *Rose, Standley, and Russell* 13126 (N, Y). Ortiz to Empalme, *Wiggins* 6330 (S). Queriego to Cd. Obregón, *Wiggins* 6444 (S). Santa Ana, *Abrams* 13249 (S). Sierra Blanca, *Lumholtz* 20 (G). Sierra de Alamos, *Rose, Standley, and Russell* 12865 (N, Y).

SINALOA. Fuerte, *Rose, Standley, and Russell* 13436 (N). La Constancia, *Ortega* 5514 (G, N). Mazatlán, *Ortega* 6914 (CA). San Blas, *Rose, Standley, and Russell* 13421 (N, Y), *Jones* 3243 (P).

This appears to be the only strictly annual species of the subgenus in North America. A specimen collected at Quitobaquito, Pima County, Arizona (*Mearns* 2774), has the leaves unusually coarsely and irregularly dentate. A slender form with long pedicels, somewhat resembling the type of *S. margaritae* Brandegee, was collected near Queriego, Sonora (*Wiggins* 6444) and at Mazatlán, Sinaloa (*Ortega* 6914). The latter has the leaf blades subcuneate at base, as often occurs in subsp. *californica*.

The occurrence of what appeared to be a hybrid between *coulteri* and *emoryi* Torr. at Sacaton, Pinal County, Arizona (*Harrison and Kearney* 8469, N) was mentioned in the discussion of Variability and Hybridization (pp. 14–16). (See also pl. 9, *A, B, C.*) Another plant, which was presumably a hybrid between these species, was collected at Wittman, Maricopa County, Arizona (*Peebles and Kearney* 6812, N).

3a. **Sphaeralcea coulteri californica** (Rose) comb. nov.

S. californica Rose, Contr. U. S. Nat. Herb., 1:66, 67. 1890.

Differs from the typical form of *S. coulteri* as follows: taproot stouter; stems usually taller and stouter, up to 360 cm. long,[22] up to 6 mm. in diameter at base; leaf blades larger, 3–7 cm. long, usually narrower, sometimes only 3/5 as wide as long, more angulate-lobed, subcuneate to subcordate at base, acute or acutish at apex, usually more finely crenate; pedicels usually shorter, often much shorter, than the fruiting calyx; petals more variable in length, 6–20 mm. long; carpels (pl. 9, *D*) often smaller, usually less than 2 mm. high.

Type locality.—La Paz, Lower California. Type (N) collected by E. Palmer January 20-February 5, 1890, No. 18.

Geographical distribution and habitat.—Lower California, south of latitude 28° N. Inhabits roadsides, fields, and stream beds, in sandy soil.

Specimens examined.—LOWER CALIFORNIA. Santa Rosalia, *Reed* 6243 (G). Mulegé, *Johnston* 3667 (C, CA, G, N, Y), *Rose* 16663 (N, Y). San Jorge, *Brandegee* in 1889 (C). Soledad, *Brandegee* in 1890 (C). Dolores, *Collins, Kearney, and Kempton* 170 (N). La Paz, *Palmer* 18, the type collection (C, G,

[21] Locality doubtful, labeled as from California; may have been collected in Sonora.

[22] *Fide* T. S. Brandegee, as quoted by Rose.

N), *Rose* 1305 (G, N), *Johnston* 3067 (C, CA, G, N, Y), *Jones* 24088 (C, F, M, N, P), *Collins, Kearney, and Kempton* 47 (F, N), 84 (N). Todos Santos, *Johansen* 554 (CA, S). Sierra de la Trinidad, *Brandegee* in 1902 (C, N).

Most of the specimens of this subspecies are easily distinguished from typical *coulteri* by their larger, more elongate, and more pointed leaves, but specimens with broader and more rounded leaves, collected by Brandegee in the Sierra de la Trinidad and by Collins, Kearney, and Kempton at La Paz (No. 84) are less unlike the typical form of the species, although larger-leafed. Another collection at La Paz (*Jones* 24088) and one at Santa Rosalia (*Reed* 6243) have the lower leaves even more like those of typical *coulteri,* being broader than long, subcordate, and rather deeply crenate. In this subspecies, according to Rose and Brandegee (1903, p. 156), the plant is biennial or perennial, but the writer's observations at La Paz and Dolores indicate that it is, at most, biennial.

3*b*. **Sphaeralcea coulteri margaritae** (Brandegee) comb. nov.

S. margaritae Brandegee, Zoe, 5:156. 1903.

Differs from the typical form of *S. coulteri* as follows: hairs of the stem shorter, 0.3 mm. long; leaf blades relatively narrower, ⅔–¾ as wide as long; inflorescence fewer-flowered and more open, with very slender peduncles much surpassing the subtending leaves; carpels (pl. 9, *G*) often smaller, 1.2–2 mm. high.

Type locality.—Santa Margarita Island, Lower California, latitude 24° 20′ N. Type (C) collected by T. S. Brandegee, March 5, 1889.

Geographical distribution.—Lower California, latitude 26° N and southward.

Specimens examined.—Lower California. San Gregorio, *Brandegee* (C). Santa Margarita Island, *Bryant* in 1888 (C), *Brandegee* in 1889, the type collection (C, N).

This subspecies seems more nearly related to the typical form of *coulteri* than to subsp. *californica.* It differs from *coulteri* in the more elongate peduncles, the few-flowered and more open inflorescence, and the smaller leaf blades, 2–4 cm. long, with rather deeply crenate-dentate margins. The specimen collected by Brandegee at San Gregorio, with rounded, cordate lower leaves, seems to be nearly intermediate between subsp. *margaritae* and typical *coulteri.* The type specimen has a stem only 60 cm. long and the plant is described by Brandegee (1903, p. 156) as "a small annual," but it is presumably the form of which he had written previously (1889, p. 135), under the name of *S. coulteri,* that "on Santa Margarita Island it becomes four feet high."

4. **Sphaeralcea sulphurea** Watson, Proc. Am. Acad., 11:113, 125. 1876.

Plant perennial, with a rather stout, woody crown, densely whitish canescent or tomentose with short hairs, those of the stem 0.2–0.4 mm. long, with 20–25 rays. Stems numerous, up to 90 cm. long, up to 5 mm. in diameter at base. Leaf blades usually thickish, with veins not very prominent beneath, broadly ovate, deltoid or nearly orbicular, at base subcuneate to subcordate, at apex very obtuse to acutish and sometimes mucronate, 3–5-veined from the base, shallowly 3-lobed at or below the middle with rounded or acutish lobes, margin finely to rather coarsely crenate and often somewhat rugose, the larger

blades 3–9 cm. long, ⅔ as wide to wider than long. Petioles slender or rather stout, ⅓–1½ times as long as the blade. Inflorescence an interrupted, many-flowered thyrse, narrow or with the lower branches up to 12 cm. long, and often forked. Pedicels rather stout, usually much shorter than the fruiting calyx. Calyx at anthesis 5–7 mm. high, with lanceolate or deltoid-ovate, acute or short-acuminate lobes 1–2½ times as long as the tube. Petals pale yellow or whitish, sometimes purple-tinged when dry, conspicuously veined, oblanceolate or narrowly obovate, with long, narrow claws, 10–15 mm. long and ⅓–½ as wide. Column sparsely pubescent. Fruit higher than hemispherical, about ⅔ as high as the calyx. Carpels (pl. 9, *I*) about 12, with thin, chartaceous walls, 3–4.5 mm. high and ½–⅔ as wide, shallowly to rather deeply notched, the dehiscent part erect or ascending, ovate or deltoid, obtuse, muticous to short-cuspidate, the indehiscent portion forming about ⅓ of the carpel, prominently and somewhat coarsely reticulate; attaching threads short or rather long. Ovules 2 or 3. Seeds 1–3, sparsely pubescent.

Type locality.—Guadalupe Island, off the western coast of Lower California, latitude about 29° N. Type (G) collected by E. Palmer in 1875, No. 18.

Geographical distribution and habitat.—Known only from Guadalupe Island, where it is "very abundant on rocky slopes and in the crevices of the highest rocky ridges" (Watson).

Specimens examined.—GUADALUPE ISLAND. *Palmer* 18, the type collection (C, F, G, M, N, Y), *Greene* in 1885 (F, N, S), *Franceschi* 13 (C, M, P, S), in 1893 (N, Y), *Brandegee* in 1897 (C, F, Y), *Drent* in 1898 (C), *Anthony* 232 (C, F, G, M, N, S), *Mason* 1506 (CA).

This species seems to be more variable in the shape and size of the carpels than in the vegetative and floral characters. The type collection (*Palmer* 18) has carpels only about 3 mm. high, ⅔ as wide, and muticous. Specimens collected by E. L. Greene in 1885, while typical in vegetative and floral characters, are markedly aberrant in the characters of the (immature) carpels, which are 4.5 mm. high, scarcely ½ as wide, and vary from mucronulate to short-cuspidate. Brandegee's collection in 1897 included a specimen (C) having carpels very like those of the type and a specimen (Y) that has carpels intermediate between those of the type and of Greene's collection, being 3.5 mm. high, ½ as wide and muticous.

5. **Sphaeralcea palmeri** Rose, Contr. U. S. Nat. Herb., 1:23. 1890.

Plant perennial with a stout, woody crown, densely yellowish canescent with very short hairs, those of the stem 0.15–0.20 mm. long, with about 25 rays. Stems conspicuously angled, erect, rather stout. Leaf blades thick, rugose, with veins very prominent beneath, deltoid-ovate or subrhomboidal, at base cuneate, at apex truncate or retuse, 3-veined from the base, not lobed but somewhat angulate, margin crenulate, the larger blades 3.5–5 cm. long and ⅘ to quite as wide. Petioles stout, ⅕–½ as long as the blade. Inflorescence a narrow thyrse with lower branches not more than 5 cm. long. Pedicels stout, shorter than the fruiting calyx. Calyx at anthesis 6–9 mm. high, with ovate, acutish, strongly-ribbed lobes equaling in length the angulate-ribbed tube. Petals yellow, conspicuously veined, narrowly obovate, with long, narrow claws, 11–13 mm. long, ½ as wide. Column sparsely or rather copiously pubescent. Fruit higher than hemispherical, about ⅔ as high as the fruiting calyx. Carpels (pl. 9, *H*) about 17, with chartaceous walls, 4–4.5 mm. high, about ½ as wide, broadly and shallowly notched, the dehiscent portion erect, ovate,

at apex rather narrow but obtuse, muticous, the indehiscent portion forming ¼–½ of the carpel, rather prominently reticulate; attaching threads short. Seeds 2, very pubescent.

Type locality.—Guadalupe Island, off the western coast of Lower California. Type (N) collected by E. Palmer, March 29, 1889, No. 867.

Geographical distribution and habitat.—Known only from Guadalupe Island, where it is "found in all exposed parts on the south end of the island" (Rose).

Specimens examined.—Guadalupe Island. *Palmer* 867, the type collection (C, G, N, Y), 868 (N).

Palmer's two numbers are practically identical and are very different, in vegetative characters, from *S. sulphurea* Watson, the only other species of Sphaeralcea known to occur on Guadalupe Island. It should be noted, however, that the collection by Greene, referred to under *sulphurea,* in its relatively high and narrow carpels more nearly resembles *palmeri* than the type of *sulphurea,* although the carpels are more pointed than in *palmeri.* The petals, in the herbarium specimens of *palmeri,* appear to be pale yellow, but Rose described them as "sometimes pinkish."

The writer was informed by J. T. Howell that *S. palmeri* is found in the more arid, southern part of the island, and that *S. sulphurea* occurs in the more humid, northern portion.

6. **Sphaeralcea axillaris** Watson, Proc. Am. Acad., 24:41. 1889.

Plant perennial or, apparently, sometimes annual, densely canescent or tomentose, especially on the young parts, with short hairs, those of the stem 0.15–0.3 mm. long, with 12–20 rays. Stems herbaceous or slightly lignescent near base, erect or ascending, up to 240 cm. long, up to 5 mm. in diameter at base. Leaf blades thin or thickish, with veins rather prominent beneath, deltoid-ovate, ovate-lanceolate or subrhombic, at base cuneate to cordate, at apex obtuse to short-acuminate, 3–5-veined from the base, not lobed or very shallowly 3-lobed or angulate below the middle, margin shallowly to somewhat deeply crenate, the larger blades 3–9 cm. long and ⅖–⅘ as wide. Petioles rather stout, ⅓–⅔ as long as the blade. Inflorescence thyrsoid with long internodes, many-flowered, the lower branches sometimes elongate and racemiform. Pedicels slender or rather stout, usually shorter than the fruiting calyx. Calyx at anthesis 6–9 mm. high, with lanceolate or ovate-lanceolate, acuminate lobes slightly longer than to nearly 3 times as long as the tube. Petals pink or white, often drying violet or yellowish, 12–17 mm. long. Column more or less pubescent. Fruit somewhat higher than hemispherical, about ⅗ as high as the calyx. Carpels (pl. 9, *K*) 10–16, with very thin, scarious walls, about 4 mm. high and ⅖–½ as wide, usually deeply and rather narrowly notched, the dehiscent part erect, ovate or deltoid, narrowed but obtuse at apex, muticous, mucronate or cuspidate with cusps up to nearly 1 mm. long, the indehiscent portion forming ⅓–½ of the carpel, prominently but usually rather finely reticulate, fenestrate, often nigrescent, moderately rugose-tuberculate to nearly smooth on the back; attaching threads fragile, usually very short, sometimes apparently wanting. Ovules 2. Seeds 1 or 2, more or less pubescent.

Type locality.—Mulegé, Lower California. Type (G) collected by E. Palmer in 1887, No. 17.

Geographical distribution and habitat.—East coast of Lower California, between latitude 27° and 25° N. Inhabits roadsides, fields, talus slopes, and stream beds, in light soils.

Specimens examined.—LOWER CALIFORNIA. San Marcos Island, *Johnston* 3616 (CA, G, N). Mulegé, *Palmer* 17, the type collection (G, N), *Rose* 16662 (N, Y), *Johnston* 3669 (C, CA, G, M, N, Y). Dolores, *Collins, Kearney, and Kempton* 168 (F, N).

The type specimen differs from the others in its more conspicuously cuspidate carpels.

6a. **Sphaeralcea axillaris violacea** (Rose) comb. nov.

S. violacea Rose, Contr. U. S. Nat. Herb., 1:81. 1890.

S. albiflora Rose, Contr. U. S. Nat. Herb., 1:81. 1890.

Differs from the typical form of *axillaris* as follows: fruit not higher than hemispherical, about ½ as high as the calyx; carpels (pl. 9, *J*) 2–3 mm. high, ⅔ to very nearly as wide, more or less reniform, the dehiscent portion sometimes ascending rather than erect, very obtuse at apex, muticous or occasionally mucronate, the indehiscent portion forming sometimes as much as ⅔ of the carpel, sometimes slightly wider than the dehiscent portion.

Type locality.—Santa Rosalia, Lower California. Type (N) collected by E. Palmer, March 15, 1890, No. 206.

Geographical distribution and habitat.—Lower California, from latitude 27° 30′ N southward. Inhabits roadsides and fields, in light soil.

Specimens examined.—LOWER CALIFORNIA. Santa Rosalia, *Palmer* 205[28] (G, N), 206, the type collection (G, N). San Ignacio, *Collins, Kearney, and Kempton* 247 (CA, N). Miraflores, *Jones* 24203 (P). Laguna Mountains, *Jones* 24204 (P). San José del Cabo, *Brandegee* 59 (C, F, S), in 1897 (C, Y), *Anthony* 350 (C, G, M, N, S), *Rose* 16496 (N), *Jones* 24046 (C, CA, M, N, P). Cape San Lucas, *Xantus* 10 (G, N, Y).

This subspecies is highly variable in the characters of its carpels. Extreme forms are represented by the type collections of *S. violacea* Rose (*Palmer* 206) and *S. albiflora* Rose (*Palmer* 205). These have relatively very small, reniform carpels that are ⅔ reticulate, suggesting a relationship to the Coulterianae that would not be suspected from examination of the typical form of *S. axillaris*. Specimens more or less intermediate between these two collections by Palmer and typical *axillaris*, having larger and less reniform carpels, are: *Xantus* 10, *Anthony* 350, and *Collins, Kearney, and Kempton* 247.

7. **Sphaeralcea hainesii** Brandegee, Proc. Calif. Acad. Sci., ser. 2, 2:136. 1889.

Plant annual or perennial, with a rather stout taproot, densely whitish or yellowish canescent, or the young parts tomentose, with short hairs, those of the stem 0.2–0.4 mm. long, with 12–25 rays. Stems erect, usually tall and stout, up to 180 cm. long, up to 6 mm. in diameter at base. Leaf blades thin or thickish, flat or somewhat rugose, with veins usually prominent beneath, ovate-oblong to very broadly ovate, at base truncate or cordate, at apex obtuse or acutish, 5–7-veined from the base, shallowly 3- to 5-lobed, margin crenulate to coarsely crenate, the larger blades 6–10 cm. long and ⅗ to quite as wide. Petioles stout, ⅓ as long to longer than the blade. Inflorescence thyrsoid-glomerate, narrow throughout or with the lower branches elongate. Pedicels stout, much shorter than the fruiting calyx. Calyx at anthesis 8–13 mm. high, with lanceolate or ovate-lanceolate, often long-acuminate lobes 2–2½ times as long as the tube. Petals grenadine or grenadine-pink, 12–20 mm. long. Column sparsely pubescent. Fruit truncate-conical, ⅗–⅔ as high as the calyx. Car-

[28] Type collection of *S. albiflora* Rose.

pels (pl. 10, *A*) 10–16, with thin, usually scarious walls, free or connate at maturity, often not separable without tearing, 4–6 mm. high, about ½ as wide, broadly and shallowly notched, the dehiscent portion erect, ovate (often broadly so), very obtuse at apex, usually muticous but sometimes short-cuspidate, the indehiscent portion forming ⅕–⅖ of the carpel, narrower (usually conspicuously narrower) than the dehiscent portion, finely but rather prominently reticulate; attaching threads usually short and sometimes apparently wanting. Ovules 3. Seeds 2–3, copiously pubescent.

Type locality.—Jesús María, Lower California. Type (C) collected by T. S. Brandegee, April 11, 1889.

Geographical distribution and habitat.—Lower California, from latitude 29° 45′ to 25° N, chiefly along the eastern coast and on islands in the Gulf of California, at or near sea level. Grows in cultivated fields and sandy "washes."

Specimens examined.—Lower California. San Francisquito Bay, *Johnston* 3556 (CA, N), *Rose* 16731 (N, Y). Las Animas Bay, *Johnston* 3506 (C, CA, G, N). San Pedro Mártir Island, *Palmer* 405 (C, G, N, Y), *Johnston* 3145 (C, CA, G, M, N, S, Y).[24] San Marcos Island, *Collins, Kearney, and Kempton* 249 (CA, F, N). Mulegé, *Rose* 16664 (N, Y), *Johnston* 3675 (CA, N). Jesús María, *Brandegee* in 1889, the type collection (C). Dolores, *Collins, Kearney, and Kempton* 169 (N). Burro Canyon, *Brandegee* in 1893 (C).

This species, as seen by the writer at Dolores, grew as a weed in cultivated fields, where it apparently was an annual, but Johnston records that on San Pedro Mártir "it is the most abundant herbaceous perennial on the island." It is somewhat vaguely defined, although most of the specimens referred here seem sufficiently distinct from other species. *S. hainesii* is related, apparently, to *S. emoryi* Torr., but the conspicuously narrowed basal portion of the carpel separates it from all forms of the latter except, occasionally, subsp. *arida*. It bears some resemblance to *S. axillaris* Wats., an inhabitant of the same region, but *axillaris* is readily distinguished by its differently colored petals and by its carpels, that are not connate and have the indehiscent portion as wide as or somewhat wider than the dehiscent portion, more prominently reticulate and often nigrescent.

There is considerable variation in the pubescence, this being rather long and loose in the type but very short and scurf-like, resembling that of *orcuttii*, in other specimens. *Johnston* 3506 from Las Animas Bay is aberrant in its relatively thick-walled carpels. Palmer's specimens from San Pedro Mártir Island (No. 405) have angulate stems.

8. **Sphaeralcea emoryi** Torrey, *in* Gray, Mem. Am. Acad., n. ser., 4:23. 1849.

Plant perennial, with a stout, woody crown, grayish-canescent, usually very densely so or even tomentose; hairs of the stem 0.25–0.40 mm. long, with 12–20 rays. Stems several or many, erect or nearly so, up to at least 120 cm. long, up to 5 mm. in diameter at base. Leaf blades usually thickish with veins prominent beneath, flat or somewhat rugose, ovate-oblong to broadly ovate, at base more or less cordate (rarely subcuneate), at apex obtuse or acutish, sometimes mucronate, 3–5-veined from the base, merely angulate or shallowly indented near the base with the projections usually broad and rounded, margin crenulate to coarsely and irregularly crenate or sometimes dentate, the

[24] Labeled, in some of the herbaria, as from Espíritu Santo Island, which is considerably south of the range of the species as otherwise known.

larger blades 3–9 cm. long and ½–¾ as wide. Petioles slender or stout, ¼ as long as to nearly equaling the blade. Inflorescence an interrupted many-flowered thyrse, usually very narrow but the lower branches sometimes up to 12 cm. long, conspicuously leafy nearly to the apex. Pedicels stout, usually shorter than the calyx. Calyx at anthesis 5–10 mm. high, with deltoid-ovate and acute, or lanceolate and acuminate, lobes 1–2 times as long as the tube. Petals usually grenadine but often pink or lavender, 10–20 mm. long. Column pubescent, often copiously. Fruit higher than hemispherical, usually truncate-conical, ⅔ as high as to slightly higher than the calyx. Carpels (pl. 10, *B*) 11–16, with chartaceous walls, 3.5–6 mm. high and ⅖–⅗ as wide, usually rather deeply notched, with a prominent ventral beak, the dehiscent portion erect, ovate, narrowed to an obtuse or acutish apex, usually cuspidate with cusps up to 1.5 mm. long but sometimes merely mucronate (rarely muticous), the indehiscent portion forming ⅓–½ of the carpel, prominently and usually coarsely reticulate, sometimes nigrescent, usually more or less rugose-tuberculate and sometimes muricate dorsally; attaching threads usually rather short and fragile. Ovules 2. Seeds usually 2, often copiously pubescent, rarely glabrous.

Type locality.—Valley of the Gila River, Yuma County, Arizona. Type (Y) collected by W. H. Emory, November 22, 1846.

Geographical distribution and habitat.—Southern Nevada to southern Arizona, southern California, and northern Lower California (probably also in northwestern Sonora), chiefly in the drainage basin of the Colorado River, at elevations from below to about 2000 feet above sea level. Inhabits roadsides and fields, in sandy or loamy soil.

Specimens examined.—NEVADA. Clark County: Las Vegas, *Rydberg* in 1895 (Y), *Tidestrom* 9069 (G, N, Y), *Wooton* in 1916 (N).

ARIZONA. Mohave County: Fort Mojave, *Jared* 12 (G). Hackberry to Peach Springs, *Braem* in 1927 (S). Kingman to Peach Springs, *Eastwood* 18440 (CA). Pinal County: Maricopa, *Eastwood* 6315 (CA). Maricopa County: Agua Caliente, *Carlson* in 1914 (CA). Gila Bend, *Harrison and Kearney* 9070 (N). Sentinel, *Harrison and Kearney* 6251 (N), *Peebles, Harrison, and Kearney* 4914 (N), 4977 (N). Cochise County: Benson, *Lemmon* 593 (C, G).[25] Pima County: Tucson, *Toumey* 5 (G). Yuma County: Laguna Dam, *Monnet* 1084 (CA). Wellton, *Bradley* in 1928 (CA). Wenden, *Peebles and Fulton* 8501 (N). Yuma, *Eastwood* 6332 (CA), *Parish* 8320 (S), *Thornber* in 1912 (A), *Swingle* 257 (A). Gila River, *Emory* in 1846, the type collection (G, Y). Yuma (?) County: Gila River, *Antisell* 32 (G). Colorado River bottoms, *Schott* in 1855, part (F).

CALIFORNIA. Riverside County: Indio, *Parish* 8321 (G, S). McCoy Wash, *Hall* 5933 (C). Imperial County: Bard, *Thornber* in 1912 (A), *Harrison and Kearney* 8728 (N, Y), 9151 (N), 9156 (N, Y). Fort Yuma, *Dubarry* in 1855 (Y), *Jones* in 1906 (S), *Parish* 8492 (S). Glamis, *Eby* in 1901 (M). Paloverde, *Schellenger* 4 (C).

LOWER CALIFORNIA. Cocopah Mountains, *Macdougal* 152 (Y).

This rather poorly defined species seems to connect *S. ambigua* Gray with *S. angustifolia* (Cav.) Don, resembling the former in its usually coarsely and prominently reticulate carpels and the latter in its relatively narrow carpels, coarser pubescence, contracted inflorescence, somewhat elongate leaves, and smaller flowers. The frequent occurrence in Arizona of specimens interme-

[25] Locality given as Santa Catalina Mountains, Pima County, on the label of the specimen in the Gray Herbarium.

diate between *emoryi* and *ambigua* and presumably of hybrid origin, is discussed under the latter species. There is a rather striking resemblance between *emoryi* and *angustifolia,* especially the broad-leafed form of the latter species (subsp. *lobata*). In *emoryi,* as compared with *angustifolia lobata,* however, the leaves are usually shorter and broader, more or less cordate instead of cuneate at base, obtuse or acutish instead of acuminate at apex, and the basal projections are usually more rounded and more divergent. Also the carpels of *emoryi* are usually more prominently and coarsely reticulate, have shorter and more fragile attaching threads, and are not connate at maturity. The geographical distribution of *emoryi* is more like that of *ambigua, angustifolia* being a species of more southeastern range.

S. emoryi bears a noticeable resemblance, in its vegetative characters and inflorescence, to *S. fulva* Greene, a plant of western Lower California, but may be distinguished from the latter by its grayish or whitish (not yellowish) pubescence and its narrower, usually cuspidate carpels. The carpels of *emoryi* (pls. 9 *B*, 10 *B*) frequently resemble those of *S. subhastata* Coulter (pl. 11, *G, H*), but these species are very dissimilar in other characters. The confusion of *emoryi* with *S. endlichii* Ulbrich, a wholly different species inhabiting northeastern Mexico, will be mentioned under the latter species.

A form of *emoryi* that occurs rather commonly in irrigated land on both sides of the Colorado River, near Yuma, Arizona, is exceptionally large-leafed and few-flowered and has pink or lavender petals.

8*a*. **Sphaeralcea emoryi variabilis** (Cockerell) comb. nov.

S. variabilis Cockerell, Am. Naturalist, 34:291. 1900.

S. fendleri californica Parish, Zoe, 5:71, 72. 1900. Not *S. californica* Rose, 1890.

S. fendleri variabilis Cockerell, Bull. So. Calif. Acad. Sci., 1:108. 1902.

Differs from the typical form of *S. emoryi* as follows: stems and leaves often more sparsely pubescent and greener; leaf blades (pl. 8) usually thinner, 3-cleft or parted, rarely divided, with the lateral lobes usually broad and rounded but sometimes acutish and sometimes deeply cleft, the mid-lobe 3–8 times as long as the lateral ones, margin usually more deeply crenate or dentate, the mid-lobe sometimes pinnately several-cleft; carpels (pl. 9, *B*) more frequently long-cuspidate.

Type locality.—Phoenix, Arizona. Type (NM) collected by T. D. A. Cockerell in October, 1899.

Geographical distribution and habitat.—Southern and western Arizona and southern California, at elevations from below to about 2500 feet above sea level. Inhabits roadsides and fields, in sandy or loamy soil.

Specimens examined (selected).—ARIZONA. Mohave County: Fort Mojave, *Cooper* in 1860 (G, N), *Harrison and Kearney* 7557 (N). Colorado River above Williams River, *Grinnell* in 1910 (C). Gila County: Winkelman, *Harrison* 8461 (N). Pinal County: Casa Grande, *Peebles* 7385 (N). Florence, *Fulton* 7681 (CA), *Harrison and Kearney* 6635 (N), 6638 (CA). Redrock, *Peebles, Harrison, and Kearney* 6501 (N), 6503 (Y). Sacaton, *Peebles* 3871 (N). Santan, *Harrison and Kearney* 8674 (N). Maricopa County: Aguila, *Jones* 26329 (M, P). Chandler, *Harrison and Kearney* 8389 (N). Glendale, *Eastwood* 6128 (CA). Litchfield, *Peebles, Harrison, and Kearney* 218 (N). Phoenix, *Cockerell* in 1899, the type collection (N, NM, Y), in 1910 (Y),

Jones in 1903 (P, S, Y). Pima County: Fort Lowell, *Griffiths* 1573 (Y). Marana, *Harrison* 8696 (N, Y). Sabino Canyon, *Thornber* 4886 (A). Tucson, *Bottimer* 271 (N), *Toumey* 81, in part (S), in 1894 (N). Yuma County: Mohawk, *Harrison and Kearney* 9139 (N).

CALIFORNIA. San Bernardino County: Colton, *Parish* 2846 (G, Y).[26] Redlands, *Parish* 4613 (C, N, S, Y). San Bernardino Mountains, southern slope, *Parish* 5572 (G), 5720 (C), 5725 (Y), 5730 (S). Upland, *Parish* 11174 (C, G), *Johnston* 1371 (C, N, P, S), 1936 (C, G, P). Warrens Well, *Brandegee* in 1902 (C). Riverside County: Blythe, *Jaeger* 790 (N, S). Chuckawalla Valley, *Munz and Keck* 4928 (C, P). Indio, *Augsbury* in 1930 (CA), *Jones* in 1903 (P), *Minthorn* 2 (C), *Parish* 8319, in part (G), *Peebles and Loomis* 116 (N), *Spencer* 1456 (F, G, P). Mecca, *Parish* 8318 (G, S).

The name *variabilis* is very appropriate for this form, the leaves varying from only slightly more lobed or cleft than in typical *emoryi* to 3-divided with the divisions petiolulate, as in *Harrison and Kearney* 8389 (N), Chandler, Arizona. The great range of variation in this character is shown in plate 8. There is a tendency for the leaves of the same individual to be more nearly entire in the late summer and fall than in the spring. There is also great variation in the color of the flowers of subsp. *variabilis*. The California specimens, and many of those from Arizona, have the grenadine petals usual in the subgenus, but differently colored forms are abundant at roadsides in parts of Pinal and Maricopa counties, Arizona. These have the petals white or of a great variety of tints of pink and pale purple, the anthers cream-colored, pink, lavender, dark red or nearly black, the pollen from pale cream to bright yellow, and the pistils from nearly white through various shades of red and purple to nearly black. The probability that this form of *emoryi*, as well as the typical form, frequently hybridizes with *S. ambigua* Gray, is discussed under the latter species.

In south-central Arizona, *emoryi variabilis* is a very abundant and conspicuous roadside plant. The stems are often very numerous, 170 from a single root having been counted.

The typical form of *emoryi* is prevalent in and near the valley of the Colorado River, but is replaced, almost entirely, by the subspecies *variabilis* at both the eastern and western extremities of its range. The occurrence of the latter form in the San Bernardino region seems rather remarkable and was attributed by Cockerell (1902, p. 106) to introduction from Arizona. The plant may, however, be indigenous in the Colorado Desert and may have spread westward in comparatively recent years, the roadside habitat favoring such extension of range. A specimen collected at Indio, California (*Peebles and Loomis* 116, N), has the carpels much constricted dorsally, opposite the notch. A slight degree of constriction at this point has been observed in some of the Arizona specimens.

8*b*. **Sphaeralcea emoryi nevadensis** subsp. nov.

A forma typica *S. emoryi* laminis foliorum angustioribus, carpidiis parietibus tenuioribus parte indehiscente subtiliter reticulata, distinguitur.

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[26] Type collection of *S. fendleri californica* Parish.

Differs from the typical form of *emoryi* and from subsp. *variabilis,* also, as follows: leaf blades mostly only ⅓–½ as wide as long; carpels thinner-walled. very finely, although prominently, reticulate. Leaf blades at base are rounded or at most subcordate, rarely subcuneate, at apex very obtuse or retuse and usually mucronate, not lobed but often subhastately toothed near the base, with acutish teeth. From subsp. *arida,* which it resembles in its thin-walled, rather finely reticulate carpels, it is distinguished by its much narrower leaf blades.

Type locality.—St. Thomas, Nevada. Type (N) collected by L. N. Goodding May 3, 1902, No. 702.

Geographical distribution and habitat.—Southern Nevada to northern Arizona and the Colorado Desert in southeastern California, at elevations from near sea level to about 1500 feet. Grows in sandy "washes," etc.

Specimens examined.—NEVADA. Lincoln County: Virgin River, *Bailey* 1925 (N). Clark County: Las Vegas, *Jaeger* 436 (N). Moapa, *Jones* in 1904 (P). St. Thomas, *Goodding* 702, the type collection (C, F, G, M, N, P, Y), *Palmer* 63 (M, N, Y), *Tidestrom* 9158 (F, N). Clark (or Nye) County: Pahrump Valley, *Purpus* 6052 (N). Clark(?) County: St. Joe, *Jones* 5030b (N).

ARIZONA. Navajo County: Silver Lake, *Griffiths* 2698 (Y). (?) County: without locality, *Palmer* in 1869 (N).

CALIFORNIA. Riverside County: Blythe, *Munz and Harwood* 3575 (N, P). Gruendike Well, *Jaeger* 1174 (C, P).

Better material is required for a proper understanding of this form, none of the specimens now available having mature fruit. Apparently it forms a transition from *emoryi* to *angustifolia,* resembling *emoryi* in its relatively short leaf blades that are usually rounded or subcordate at base and obtuse at apex, and *angustifolia* in the relative narrowness of the leaf blades and finer reticulation of the carpels. The geographical distribution of subsp. *nevadensis* is that of *emoryi,* the range of *angustifolia* being farther east and south. Specimens that approach *angustifolia* in having the upper leaf blades more or less cuneate at base, are: *Palmer* 63, in part, St. Thomas, Nevada, and *Griffiths* 2698, Silver Lake, Arizona. Purpus' collection in Nevada (No. 6052), with wider leaf blades than the others, connects this subspecies with typical *emoryi.*

8c. **Sphaeralcea emoryi arida** (Rose) comb. nov.

S. arida Rose, Contr. U. S. Nat. Herb., 5:177. 1899.

Differs from other forms of *emoryi* as follows: leaf blades shorter and broader, not more than 5 cm. long and usually nearly or quite as wide, cleft usually far above the base. Differs from the typical form of the species, and from subsp. *variabilis,* in its usually fewer (8–12), thinner-walled, more finely reticulate and fenestrate carpels (pl. 10, *C*), that are usually more shallowly and broadly notched, have the indehiscent part often noticeably narrower than the dehiscent part and are smooth, or nearly so, dorsally; also in the usually glabrous seeds. Resembles subsp. *nevadensis* in its thin-walled and finely reticulate carpels, but the latter has much narrower leaf blades and they are cleft near the base.

Type locality.—Guaymas, Sonora. Type (N) collected by J. N. Rose, June 5–11, 1897, No. 1209.

Geographical distribution and habitat.—Southern Nevada and southeast-

ern California to northern Sinaloa, from near sea level to about 5000 feet. Inhabits roadsides and fields.

Specimens examined.—NEVADA. Clark County: Searchlight, *Parish* 10293 (C, G, M, S).

CALIFORNIA. Imperial County: Bard, *Harrison and Kearney* 9150 (N, Y). Ogilby, *Munz and Hitchcock* 12183 (C, F, N, P).

SONORA. Cochuto, *Hartman* 75 (G, N). Guaymas, *Palmer* 90 (C, G, N, Y), *Rose* 1209, the type collection (N, Y), 1209a (G, N), *Rose, Standley, and Russell* 15008 (N, Y), *Collins, Kearney, and Kempton* 253 (N). Hermosillo, *Brandegee* in 1892 (C), *Rose, Standley, and Russell* 12349 (N, Y), 12394 (F, M, N, Y). Imuris, *Abrams* 13203 (S). La Cruz de Los Cañados, *Lloyd* 373 (G). Ortiz to Empalme, *Wiggins* 6327 (S). Ortiz, *Shreve* 6113 (F).

SINALOA. Near Zaragoza, *Endlich* 703 (B).

S. emoryi arida seems to connect *S. hainesii* Brandeg., a plant of the opposite shore of the Gulf of California, with typical *emoryi*. Both *hainesii* and *arida* have in common an unusual character of the carpels, namely, the indehiscent part narrower than the dehiscent part, but this character is more constant in *hainesii*, which seems, otherwise, much more distinct from *emoryi* than is *arida*.

Rose, Standley, and Russell 12349, collected at Hermosillo, Sonora, while otherwise typical, has relatively short and broad carpels with an exceptionally pronounced ventral beak. The Nevada and California specimens have similar carpels. *Hartman* 75, collected at Cochuto, Sonora, at the unusually high elevation of 5100 feet, has exceptionally thin leaves and an exceptionally open, long-branched inflorescence. In *Collins, Kearney, and Kempton* 253, from Guaymas, Sonora, and *Harrison and Kearney* 9150 from Bard, California, the leaves are relatively narrow for this subspecies, being about 3/4 as wide as long.

9. **Sphaeralcea fulva** Greene, Pittonia, 1:201. 1888.

Plant perennial, suffrutescent, densely yellowish pubescent, hairs of the stem 0.10–0.35 mm. long, with 15–25 rays. Stems erect or ascending, up to 130 cm. long and rather stout, up to 5 mm. in diameter at base. Leaf blades usually thick and very rugose, with veins very prominent beneath, usually oblong-ovate but sometimes deltoid-ovate, at base usually subcuneate but sometimes truncate or subcordate, at apex obtuse or acutish, 3–5-veined from the base, shallowly 3-lobed near the base with rounded lobes or merely angulate, margin nearly entire to rather coarsely and irregularly crenate-dentate, the larger blades 3–5 cm. long, 3/5–4/5 as wide. Petioles stout or slender, 1/5–1/2 as long as the blade. Inflorescence usually narrowly and interruptedly thyrsoid-glomerate but sometimes more open, with the lower branches up to 5 cm. long. Pedicels stout, usually much shorter than the calyx. Calyx at anthesis 7–12 mm. high, with deltoid-ovate and acute, or oblong-lanceolate and acuminate lobes 1–3 times as long as the tube. Petals grenadine or occasionally pink or white, 10–20 mm. long. Column more or less pubescent. Fruit approximately hemispherical, about 1/2 as high as the calyx. Carpels (pl. 9, *L*) about 15, with firm, chartaceous walls, 4–5 mm. high, 3/5–3/4 as wide, helmet-shaped, shallowly or rather deeply and narrowly notched, the dehiscent portion erect, deltoid-ovate with a rather prominent ventral beak, very obtuse, muticous or mucronulate, the indehiscent part forming 1/4–1/2 of the carpel, prominently

and rather coarsely reticulate, rugose-tuberculate or nearly smooth dorsally; attaching threads short, apparently often wanting. Ovules 2. Seeds 1 or 2, more or less pubescent.

Type locality.—Cedros Island, off the west coast of Lower California, "in clay soil back from the sea" (Greene). Type (Notre Dame University) collected by E. L. Greene, May 1, 1885.

Geographical distribution.—Cedros Island and west coast of the Lower California peninsula, latitude 31° to 27° 40′ N, near sea level.

Specimens examined.—Lower California. San Telmo, *Brandegee* in 1893 (C). San Quintín Bay, *Mason* 2053 (CA, G, N), *McKeever* 24, 25, 26 (N), 27 (Y), *Orcutt* in 1886 (N, Y), *Palmer* 616 (Y), 624 (C, N, Y), 693 (C, N). Socorro, *Brandegee* in 1889 (C, F). Cedros Island, *Anthony* 56 (C, CA, F, G, M, N, P, S, Y), 304 (C, F, G, M, N, P, S), *Brandegee* in 1897 (C), *Greene* in 1885, the type collection (G), *Mason* 2013 (CA, G, N, S, Y), *Palmer* 699 (G, N), *Pond* in 1889 (N, Y), *Rose* 16153 (N, Y), *Solis* 30 (N), *Veatch* (C). Lagoon Head, *Palmer* 798 (G, N). San Bertolomé (Turtle) Bay, *Mason* 1968 (CA).

In its typical form, as it occurs on Cedros Island, *fulva* seems a very distinct species. But specimens collected on the mainland of the peninsula, especially around San Quintín Bay, tend to be less conspicuously fulvous, the leaf blades are often thinner, less rugose, shorter, and relatively broader, and the inflorescence is occasionally more open and fewer-flowered. The most nearly related species is *S. ambigua* Gray, to which an approach is indicated by some of these variant characters. It is perhaps significant that the specimens showing them were collected in places less remote than Cedros Island from the known range of *ambigua.*

10. **Sphaeralcea ambigua** Gray, Proc. Am. Acad., 22:292. 1887.

S. emoryi Gray, *in* Ives Exp. Colorado River, Bot., 8. 1860. Not Torrey, 1849.

S. macdougalii Rose and Standley, Contr. U. S. Nat. Herb., 16:13, 14. 1912.

S. ambigua keckii Munz, Bull. So. Calif. Acad. Sci., 31:68. 1932.

Plant perennial, with a thick, woody crown, suffrutescent or sometimes suffruticose, whitish or yellowish canescent, usually densely so, especially on the young stems and leaves, with usually very short hairs, those of the stem 0.1–0.3 mm. long, with 12–25 rays. Stems numerous (sometimes 100 or more), erect or ascending, up to 100 cm. long and up to 7 mm. in diameter at base. Leaf blades thickish, usually rugose, with veins prominent beneath, broadly ovate, deltoid or nearly orbicular, at base subcordate to deeply cordate with an open sinus, at apex usually very obtuse, truncate or slightly retuse (rarely acutish), margin crenulate to coarsely and irregularly crenate or crenate-dentate, 5- (rarely 7-) veined from the base, 3-lobed near the middle (usually very shallowly) with rounded (rarely acutish) lobes, the lateral lobes sometimes shallowly cleft, the larger blades 2–6 cm. long and $\frac{4}{5}$–$\frac{6}{5}$ as wide. Inflorescence typically an open, few- to many-flowered panicle with the lower branches up to 11 cm. long, but sometimes narrowly thyrsoid. Pedicels usually stout, usually shorter (often much shorter) than the calyx. Calyx usually densely pubescent on its whole outer surface (but sometimes glabrescent), at anthesis 6–20 mm. high, with lanceolate or oblong-lanceolate, attenuate-acuminate lobes 1–4 (rarely less than 2) times as long as the tube. Petals grenadine or grenadine-pink, 15–35 mm. long. Column pubescent, usually sparsely so (rarely glabrous). Fruit approximately hemispherical, broader than high,

usually ½–⅔ as high as the calyx. Carpels (pl. 9, *M*) 12–16, with thickish, chartaceous walls, 3.5–6 mm. high, usually about ⅔ as wide, helmet-shaped, usually narrowly and rather deeply notched, the dehiscent portion erect, deltoid-ovate with a very prominent ventral beak, very obtuse, usually muticous or mucronulate, sometimes sparsely spinulose dorsally near the apex, the indehiscent portion forming usually about ⅓ of the carpel, prominently and usually coarsely reticulate, usually rugose or muricate dorsally; attaching threads fragile and usually short, attached near the base of the carpel, sometimes apparently wanting. Ovules 2 (rarely 1). Seeds usually 2, sparsely to copiously pubescent.

Type locality.—"Big Canyon of the Colorado." Type (G) collected by J. S. Newberry, March 7, 1858.

Geographical distribution and habitat.—Southwestern Utah and southern Nevada to northwestern Sonora and northern Lower California, at elevations usually below 3000 feet. Inhabits dry, rocky slopes and the edges of sandy "washes."

Specimens examined (selected).—UTAH. Washington County: Hurricane, *Eggleston* 14868 (N).

NEVADA. Lincoln County: Logan, *Heller* 10460 (N, Y). Clark County: Searchlight, *Eastwood* 18270 (CA, N). St. Thomas, *Tidestrom* 9151 (N, Y).

ARIZONA. Mohave County: Big Canyon of the Colorado, *Newberry* in 1858, the type collection[27] (G, N). Chemehuevis, *Jones* in 1903 (F, M, N, P, S). Fort Mojave, *Lemmon* in 1884 (C). Oatman, *Eastwood* 18182 (CA, N). Gila County: Mazatzal Mountains, *Eastwood* 16879 (CA), 17083 (G). Pinal County: Florence, *Harrison and Kearney* 6641 (CA, Y). Maricopa, *Lemmon* 16 (G). Oracle, *Eastwood* 17474 (CA). Sacaton Mountains, *Gillespie* 8918 (C, N). Maricopa County: Gila Bend, *Jones* 29380 (C). Sierra Estrella, *Peebles and Kearney* 7754 (N). Wickenburg, *Palmer* 577 (F, G, M, N, Y). Cochise County: Benson, *Lemmon* 591 (G, Y). Pima County: Tucson, *Lemmon* 29 (G). Yuma County: Ehrenberg, *Macdougal* 54 (Y). Mohawk, *Peebles and Harrison* 5019 (N). Squaw Peak, *Monnet* 1072 (CA).

CALIFORNIA. Inyo County: Darwin, *Jones* in 1897 (P, S). Darwin Falls, *Ferris* 7415 (S, Y). Furnace Creek Wash, *J. T. Howell* 3672 (CA). Panamint Mountains, *Coville and Gilman* 391 (N), *Ferris* 8013 (S), *J. T. Howell* 3975 (CA). Ryan, *Hitchcock* 12328 (C). San Bernardino County: Ash Hill, *Hall* 6095 (C). Bagdad to Twenty Nine Palms, *Brandegee* in 1902 (C, N). Mopas Mountains, *Ferris and Bacigalupi* 8203 (C, F, S). Needles, *Jones* 3858 (A, F, N, P, S, Y). Providence Mountains, *Brandegee* in 1902 (C). Yucca Valley, *Eastwood* 18654 (CA). Riverside County: Blythe, *Jones* in 1924 (C, N, P). Corn Spring, *Munz and Keck* 4835[28] (C, CA, P). Eagle Mountains, *Munz and Keck* 4946 (C, P). Mecca, *McKibben* in 1904 (C). Painted Canyon, *J. T. Howell* 3528 (CA, S). Palm Springs, *Eastwood* 2988 (CA, G, M, N), *Jones* in 1903 (P), *Parish* 4108 (C, CA, G, M, N, Y). Shaver Well, *Jones* in 1926 (P, S). Imperial County: Ogilby, *Munz and Hitchcock* 12154 (N, P). San Felipe, *Thurber* 635 (G, N, Y). San Diego County: Box Canyon, *Munz and Hitchcock* 12056 (C, F, N, P). Palm Canyon, San Ysidro, *Meyer* 59 (C). Palm Creek, *Brandegee* in 1895 (C). Santa Ysabel, *Henshaw* 71 (N, Y).

SONORA. Kino Point, *Macdougal and Shreve* 37 (N). Pinacate Mountains, *Macdougal* 45[29] (N).

LOWER CALIFORNIA. Canyon Cantillas, *Orcutt* 1109 (C). Los Angeles Bay, *Palmer* 537 (G, N, Y).

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[27] May have been collected in adjacent California or Nevada.

[28] Type collection of *S. ambigua keckii* Munz.

[29] Type collection of *S. macdougallii* Rose and Standley.

Even disregarding the extreme forms here treated as subspecies, *ambigua* is one of the most variable of the North American species. Some of the more striking variations are as follows: leaves deeply lobed and toothed; inflorescence narrow, thyrsoid, with short peduncles, a character proper to subspp. *monticola* and *rugosa* but shown also by numerous specimens from Arizona and from the vicinity of Palm Springs, California, that seem nearer the typical form in other respects; calyx with tube glabrescent and lobes either pubescent or glabrescent except on the margins and inner surface, a condition noted in one specimen from Nevada and several from California; calyx pubescence of unusual character, the outer surface being white-tomentose with unusually short hairs, in a specimen from Palm Springs, California (*Jones* in 1903), and exceptionally long-pubescent, with hairs of a fulvous color except on the margins of the lobes, where they are pinkish-white, in a specimen from Shaver Well, California (*Jones* in 1926); flowers (at least the early season ones) very large, with petals 25–35 mm. long (*S. ambigua keckii* Munz), a form of especially frequent occurrence in the Colorado Desert of California, but also represented in Inyo County and in southwestern Arizona.

Hybridization between *ambigua* and *S. emoryi* Torr., as was mentioned under Variability and Hybridization (pp. 14–16), seems to occur frequently where the ranges of these species overlap, especially in Pinal and Maricopa counties, Arizona, where *emoryi* is represented chiefly by subsp. *variabilis*. The contrasting characters of these species, variously recombined in the supposed hybrids, are: leaf blades not or very little longer than wide in *ambigua*, about twice as long as wide in *emoryi;* very shallowly lobed near the middle, with broad, rounded lobes in *ambigua,* often deeply lobed, or even parted, near the base, with narrower lobes, in *emoryi;* inflorescence typically an open panicle in *ambigua,* a narrow, interrupted thyrse in *emoryi;* calyx large, usually more than 10 mm. high in *ambigua,* smaller, usually less than 10 mm. high in *emoryi*; fruit approximately hemispherical and usually not more than ⅔ as high as the calyx in *ambigua,* usually truncate-conical and nearly equaling the calyx in *emoryi;* carpels usually ⅔ as wide as high, very obtuse and muticous or mucronulate in *ambigua,* usually only about ½ as wide as high, often acutish and usually cuspidate in *emoryi.* In localities in Arizona where the form of *ambigua* with pink or lavender petals and purple anthers (subsp. *rosacea*) occurs, these colors are also seen in many of the plants that appear to be *ambigua* × *emoryi.* This presumable interspecies hybrid also occurs sporadically in southeastern California. A specimen from the Colorado Desert (*Orcutt,* C) has typical carpels of *emoryi,* but resembles *ambigua* in its leaf shape, open inflorescence, and large calyx. Hybridization with *emoryi* is suggested, also, by specimens from the Mojave Desert that have high, narrow, often cuspidate carpels. These are discussed under *S. ambigua monticola.*

It is suspected that *ambigua* crosses occasionally with *S. parvifolia* A. Nels. in northern and central Arizona. This combination is indicated by the characters of specimens from Kingman (*Eastwood* 18074, in part, 18398, CA, N), Aquarius Mountains (*Eastwood* 18354, CA), and Congress Junction (*Jones*

in 1903, P). A specimen from the Mazatzal Mountains, Arizona (*Eastwood* 16931, CA), presents a combination of characters suggesting that it may be a hybrid between *ambigua* and *S. rusbyi* Gray. Specimens from the Tucson Mountains, Arizona, with purple petals (*Thornber* 4002, A; *Bartram* 185, R), suggest hybridization with *S. laxa* Woot. and Standl. or with the purple-flowered form of *S. fendleri* that occurs in the Tucson region.

10*a*. **Sphaeralcea ambigua rosacea** (Munz and Johnston) comb. nov.

S. rosacea Munz and Johnston, Bull. Torrey Club, 49:353. 1922.

S. purpurea Parish, *in* Jepson, Man. Fl. Pl. Cal., 635. 1925.

Differs from the typical form of *S. ambigua* chiefly in the color of the petals, which are pale purplish pink, often drying violet. The anthers, also, are usually purple. The stems are often conspicuously and very densely white-pubescent with very short hairs and the carpels are often pronouncedly mucronate.

Type locality.—Palm Springs, Riverside County, California. Type (CA) collected by Alice B. Chittenden, April 2, 1917.

Geographical distribution and habitat.—Southern Arizona, southeastern California, and the northern edge of Lower California, at elevations of 300–3500 (usually 1500–2500) feet. Habitat similar to that of typical *S. ambigua.*

Specimens examined.—ARIZONA. Pinal County: Picacho Mountains, *Peebles, Harrison, and Kearney* 6481 (CA, N), 7656 (N). Santan Mountains, *Peebles, Harrison, and Kearney* 1244 (N). Maricopa County: Chandler Heights, *Harrison and Kearney* 7662 (N, Y). Pima County: Tucson, *Toumey* 81, in part (A, CA, N, S). Yuma County: Quartzite, *Jones* 26346 (P).

CALIFORNIA. Riverside County: Palm Springs and vicinity, *Johnston* 1040 (S), in 1917 (C, P), *Munz* 12008 (C, F, N, P), *Parish* 4109 (C, G, M, N, S, Y), *Spencer* 730, etc. (G). Imperial County: Coyote Wells, *Brandegee* in 1905 (C, N). Mountain Springs, *Ferris and Bacigalupi* 8238 (C, S), *Meyer* 422 (C), *Munz* 9625 (C, N, P), *Parish* 9101 (G, P, S), *Schoenfeldt* 3061 (N), *Spencer* 728 (G, N, P, Y). San Diego County: Jacumba, *Munz* 8080 (G, P). Jacumba to Mountain Springs, *Ferris* 7054 (S, Y).

LOWER CALIFORNIA. Laguna Maquata, *Orcutt* 2026 (N). Mexicali (west of), *Munz* 9586 (P, S).

This form is of sporadic occurrence in Arizona, but in California, from the San Jacinto Range southward to beyond the international boundary, it is abundant on the desert slopes of the mountains. As seen by the writer in that region, it grows unmixed with the typical form of the species and usually at somewhat higher elevations, ascending to the lower edge of the Yucca-chaparral belt. Because of its somewhat distinct geographical position, at least in California, it seems justifiable to treat *rosacea* as a subspecies, rather than as a mere flower-color variation of *ambigua*. The California plant is usually recognizable, even when not in flower, by the conspicuously white stems. This character is less marked in the Arizona form, and even in a few of the California specimens the pubescence of the stems is yellowish. Bright yellow pubescence of the upper surface and margin of the leaf blades was noted in two specimens from near the international boundary (Mountain Springs, *Schoenfeldt* 3061; Laguna Maquata, *Orcutt* 2026). In another specimen collected at Mountain Springs (*Munz* 9625) the backs of the carpels have several very slender, reflexed spinelets near the apex. The inflorescence is

usually open-paniculate, but in a specimen collected west of Mexicali, Lower California (*Munz* 9586), it is contracted, as in subsp. *rugosa,* which this specimen resembles also in its yellowish pubescence and in its occurrence at the relatively high elevation of 3500 feet.

Contrary to the original description of *S. rosacea,* the indehiscent part of the carpel is reticulate, usually coarsely and prominently so, as in typical *ambigua,* and the carpels are 2-seeded.

10*b*. Sphaeralcea ambigua monticola nom. nov.

S. pulchella Jepson, Man. Fl. Pl. Cal., 635. 1925. Not Philippi, 1892.

Differs from the typical form of *S. ambigua* as follows: stems herbaceous above the crown, few, seldom more than 60 cm. long and usually much shorter; leaf blades seldom more than 3 cm. long and often much smaller; inflorescence usually a narrow, few-flowered thyrse but occasionally more open, with the lower branches up to 15 cm. long; fruit usually higher relative to the calyx, sometimes nearly equaling it; carpels (pl. 9, *N*) more frequently mucronate or short-cuspidate, the reticulate portion often smaller and less rugose dorsally.

Type locality.—Hanaupah Canyon, Panamint Mountains, Inyo County, California, at an elevation of 4000 feet. Type (J) collected by W. L. Jepson, No. 7064.

Geographical distribution and habitat.—Southwestern Utah and southern and western Nevada to eastern California (south to San Bernardino County) at elevations of 4000–7000 feet. Inhabits the dry rocky slopes of desert mountain ranges, often in open places among pinyons and pines.

Specimens examined (selected).—UTAH. Washington County: St. George, *Palmer* 63½ (Y).

NEVADA. Storey County: Virginia City, *Eastwood* 14825 (CA). Washoe County: Glendale, *Kennedy* 1576 (A, C, CA, N, P, R, S, Y). Reno, *Jones* in 1893 (P). Sparks, *Eastwood and Howell* 14 (CA, N), *Heller* 8652 (F, G, N, S, Y). Truckee Pass, *Kennedy* 732 (A, C, M, R, S), 2025 (C, M, R, S). Churchill County: Carson Sink, *Eastwood and Howell* 89 (CA, N). Nye County: Rhyolite, *Jones* in 1907 (P, S). Esmeralda County: Columbus Marsh, *Jones* in 1927 (CA, P). Fish Lake Valley, *Ferris* 6658 (S). Lida, *Wolf* 3223 (CA, G, S). Mineral County: Candelaria, *Shockley* 1 (N), 211 (G, S). Mina, *Heller* 8367 (CA, F, G, M, N, S, Y). Douglas County: Minden, *Haley* in 1927 (CA, P, Y). Clark County: Charleston Mountains, *Purpus* in 1898 (C). Las Vegas, *Goodding* 2269 (N, R).

CALIFORNIA. Sierra County: *Lemmon* 44 (C, F, M, Y). Mono County: Rock Creek Canyon, *Feudge* 1451 (P). Inyo County: Argus Mountains, *Purpus* 5345 (C, G, M, N), 5448 (C), 5455 (C). Bishop Creek, *K. Brandegee* in 1913, in part (C). Coso Mountains, *Hall and Chandler* 7108 (C). Darwin, *Ferris* 7897 (S), *Jones* in 1897 (A, M, N, P, S), *Munz* 12495 (C, N, P). Owens Valley, *Wexton* 159 (CA). Panamint Mountains, *Coville and Funston* 634 (G, N, S, Y), *Coville and Gilman* 240 (N), *J. T. Howell* 4029 (CA, N), *Jepson* 7064, the type collection (J), *Parish* 10068 (C, S). Round Valley, *Ferris* 1393 (CA, S). Kern County: El Paso Mountains, *Abrams* 11892 (P, S). Ricardo, *J. T. Howell* 4990 (CA), *Munz* 12459 (C, F, N, P). San Bernardino County: Barstow, *Munz* 2511 (N, P, S). Cima, *K. Brandegee* in 1915 (C, Y). Kramer, *Ferris and Duncan* 2210 (CA, M, S). Mojave Desert, *Johnston* 6532 (P). Newberry Mountains, *Munz and Keck* 7832 (P). New York Mountains, *Ferris and Bacigalupi* 8088 (C, F, S). Providence Mountains, *Munz* et al. 4252

(N, P, R, S). San Bernardino Mountains, *Abrams and McGregor* 741 (S), *Ewan* 1989 (CA, R), *Hall* 7532 (C), *Parish* 3157 (A, C, M, N, Y).

This subspecies extends the range of *ambigua* much farther north and to much higher elevations than are attained by the typical form, and its distinguishing characters are mainly what would be expected in a high-altitude form. In its extreme form, *monticola* appears very different from *ambigua,* but the intergradation is so complete and both forms show so nearly parallel a series of variations that *monticola* seems best treated as a subspecies. There is almost, if not quite, as much variation as among the specimens referred by the writer to *ambigua* f. *typica.* The more striking variations are: stems exceptionally tall, up to 100 cm. long and exceptionally stout, up to 6 mm. in diameter at base; leaves exceptionally thick and rugose, a form occurring in southern Nevada and in Inyo and San Bernardino counties, California, that approaches subsp. *rugosa* in the characters mentioned but is usually fewer-flowered and with more coarsely reticulate carpels; stems glabrescent, leaves and calyx densely pubescent; inflorescence more open, with longer branches, flowers often very large, petals up to 3 cm. long, a form connecting subsp. *monticola* with typical *ambigua;* calyx glabrescent on the tube, pubescent on the lobes, or sometimes glabrescent on the whole outer surface, a variation of rather frequent occurrence; petals drying lavender, a rare color variation seen only in part of a collection at Columbus Marsh, Nevada (*Jones* in 1927), which approaches typical *ambigua* in its more open inflorescence; column elongate, anthers dark purple, in a specimen collected in the Newberry Mountains, California (*Munz and Keck* 7832).

A form of frequent occurrence in western Nevada, growing probably under exceptionally favorable conditions with respect to water supply, is characterized by often relatively tall stems, usually thin, rather deeply lobed and coarsely toothed leaf blades, and a relatively small calyx not greatly surpassing the fruit, with lobes only 1–2 times as long as the tube. Specimens of this character were collected at Virginia City (*Eastwood* 14825), Glendale (*Kennedy* 1576), Reno (*Jones* in 1893), Sparks (*Eastwood and Howell* 14, *Heller* 8652), Truckee Pass (*Kennedy* 732, 2025). Similar specimens were collected in California, in Sierra County (*Lemmon* 44) and at Round Valley, Inyo County (*Ferris* 1393). The small calyx and many-flowered, thyrsoid inflorescence of some of these specimens, especially those collected at Sparks, Nevada, suggest hybridization with *S. munroana* (Doug.) Spach, but the carpels are of *ambigua* type. In the very remarkable specimens collected by Miss Eastwood at Virginia City, the carpels are of unusually thin texture, obliquely truncate at apex, and have very few, but coarse, reticulations. The attaching threads of the carpels are developed, to a degree rarely seen in *S. ambigua,* in Mrs. Ferris' specimens from Round Valley, California.

Glabrescent specimens with thin, rather deeply incised leaf blades, collected by M. F. Gilman in 1934 in Emigrant Wash, Panamint Mountains, Inyo County, California, the type locality of *S. rusbyi eremicola* (*S. eremicola* Jepson), suggest hybridization with that form.

Perplexing forms occur in the Mojave Desert region of California, that resemble *ambigua monticola* in stature and appearance but are aberrant in having the carpels relatively high (up to 6 mm.), narrow and pointed, often cuspidate, and the leaves often distinctly longer than wide. These characters suggest hybridization with *S. emoryi* Torrey, but the latter species is not known to occur at most of the stations where the form concerned has been collected. Examples are: Bissell, Kern County, *K. Brandegee* (C, M, N, Y); Mojave, Kern County, *Davidson* in 1895 (C, G), *Eastwood* 3191a (CA), *Jones* in 1917 (C, CA, N, S); Barstow, San Bernardino County, *K. Brandegee* in 1909 (C); Kramer, San Bernardino County, *K. Brandegee* in 1905 and 1914 (C); Mojave Desert, San Bernardino County, *Parish* 610 (M, N, S), 2344 (F, Y), in 1886 (C); Victorville, San Bernardino County, *J. M. Webber* 205 (N); Antelope Valley, Los Angeles County, *Davidson* in 1895 (C); Lancaster, Los Angeles County, *Davidson* in 1893 (S); Palmdale, Los Angeles County, *Davy* 2293 (C), *Elmer* 3612 (C, G, M, N, P, S, Y), *Peirson* in 1921 (P). Similar specimens were collected near Jean and Goodsprings, Clark County, Nevada (*K. Brandegee* in 1915, C, M). Elmer's specimens from Palmdale, California, with leaves nearly twice as long as wide, are strikingly like *emoryi* except in the rather broad carpels, but Parish's specimens from the Mojave Desert, with typical *emoryi* carpels (pl. 10, *D*), are typical *ambigua monticola* in their other characters.

10*c*. **Sphaeralcea ambigua rugosa** subsp. nov.

A forma typica *S. ambiguae* inflorescentia angusta thyrsoidea, floribus saepe pluribus et minoribus, carpidiis plerumque subtiliter reticulatis, distinguitur.

Type locality.—Near Idyllwild, San Jacinto Mountains, Riverside County, California, at an elevation of about 5000 feet. Type specimen (N) collected by T. H. Kearney and J. M. Webber, August 25, 1933, from a specimen transplanted to Riverside, California, No. 202.

Geographical distribution and habitat.—Southern California and northern Lower California, occurring at elevations of from 1000 feet on the Pacific Coast in Lower California to 6000 feet in the San Jacinto Mountains, where it grows in open places in pine forests, in sandy or gravelly soil.

Specimens examined.—CALIFORNIA. San Bernardino County: Victorville, *Kearney and Webber* in 1934 (N). Riverside County: near Idyllwild, *Kearney and Webber* 202, the type collection (F, N), *Van Dyke* in 1928 (CA). San Jacinto, *Street and Durant* in 1918 (S). San Jacinto Mountains, *Hall* 751 (N), 2148 (C, M, N, S). San Jacinto Valley, *Nevin* 664 (G). Valle Vista, *Hall* in 1899 (C), *Jenkins and Street* 1952 (C). Vandeventer Flat, *Munz* 5815 (P). San Diego County: Hot Springs, *Vasey* 62 (F). Jacumba, *Abrams* 3702 (CA, G, M, N, S, Y). Cantillas(?) Mountains, *Palmer* 29 (F, M). Warner Spring, *Coombs* in 1911 (CA), *Munz and Harwood* 7306 (P).

LOWER CALIFORNIA. Tijuana, *Jones* in 1925 (P). Ensenada, *Harvey* in 1925 (P), *Jones* in 1882 (P). San Pedro Mártir Mountains, *Goldman* 1175 (N).

This form most nearly resembles subsp. *monticola*, but is of more southerly distribution and differs from most specimens of *monticola* in the yellowish rather than whitish pubescence of the stems, thicker, more prominently veined and more rugose or plicate leaf blades, narrower and more interruptedly

thyrsoid-glomerate inflorescence, more numerous and smaller flowers, and more finely reticulate carpels. The stems are often taller and stouter than is usual in *monticola* and are sometimes lignescent toward the base.

Subspecies *rugosa* resembles *S. fulva* Greene in its conspicuous, yellow pubescence and long, narrow, interruptedly thyrsoid-glomerate inflorescence. But in typical *S. fulva* the hairs are longer, the leaves are more elongate, relatively narrower, subcuneate instead of cordate, and lobed nearer the base, and the carpels are more coarsely reticulate.

10*d*. **Sphaeralcea ambigua versicolor** subsp. nov.

A forma typica *S. ambiguae,* caulibus suffruticosis, pubescentia folii diversicolore, carpidiis profundius excisis, distinguitur.

Differs from the typical form of *S. ambigua* as follows: stems more lignescent and more branched above the crown; leaf blades smaller (1–2 cm. long), tomentose, the pubescence orange-yellow on the margins, yellowish above and usually white beneath; carpels (pl. 9, *O*) more deeply notched, the depth of the notch nearly or quite equaling the width of the carpel at that point, the indehiscent part forming nearly ½ of the carpel. It is readily distinguished from subsp. *rosacea* by its grenadine-colored petals, and from subspp. *monticola* and *rugosa* by its woodier stems and open, paniculate inflorescence. The flowers are relatively small, with calyx at anthesis 7–8 mm. high and petals less than 15 mm. long; the calyx lobes are only 1–2 times as long as the tube; and the carpels are barely 4 mm. high.

Type locality.—Angel de la Guarda Island, opposite Pond Island, Gulf of California. Type (N) collected by I. M. Johnston, June 30, 1921, No. 4214.

Geographical distribution and habitat.—Coast of northern Sonora and neighboring islands, near sea level. Inhabits stony slopes, silty flats, and sandy washes (Johnston).

Specimens examined.—SONORA. Tepoca Bay, *Johnston* 3296 (CA, G, N). GULF OF CALIFORNIA. Angel de la Guarda Island, *Johnston* 3415 (CA, G, N) 4214, the type collection (C, CA, G, M, N, Y), *Rose* 16765 (N, Y). San Esteban Island, *Johnston* 3172 (CA, G, N), *Rose* 16821 (N).

This form was recognized as distinct by Rose and Standley, but was not published by them. It is perhaps entitled to specific rank, but the writer prefers to treat it as a subspecies until more material becomes available. The specimens at hand lack the lower leaves and seem to represent a late, dry-season stage, which may account for the small size of the leaves and flowers. Another reason for hesitation in assigning specific rank to *versicolor* is that one of its most striking characters, the bright yellow margin of the leaf, is met with occasionally in other forms of *ambigua*. It appears in the following specimens listed under the typical form of the species: *J. T. Howell* 3975, Panamint Mountains, California, and *Brandegee* in 1902, Bagdad to Twenty Nine Palms, California. Also in subsp. *rosacea* as represented by *Schoenfeldt* 3061, Mountain Spring, California, and by *Orcutt* 2026, Laguna Maquata, Lower California; and in subsp. *rugosa,* as represented by *Abrams* 3702, Jacumba, California. One of the specimens from San Esteban Island (*Johnston* 3172) is atypical in having the leaf blades more elongate and somewhat more deeply cleft than in the other specimens, which have the blades about

equally long and wide, and very shallowly lobed. On the coast of Sonora, the range of this subspecies nearly or quite overlaps that of typical *ambigua*.

11. **Sphaeralcea lindheimeri** Gray, Boston Jour. Nat. Hist., 6:162. 1850.

Plant perennial with a rather small crown, densely whitish pubescent with relatively very long, soft, felted hairs, those of the stem 0.9–1.5 mm. long, with 6–9 rays. Stems few, decumbent, up to 70 cm. long, up to 3.5 mm. in diameter at base. Leaf blades thin, deltoid-ovate to nearly orbicular, at base truncate or cordate with a usually open sinus, at apex rounded to acutish, 5–7-veined from the base, usually very shallowly but sometimes deeply lobed, margin shallowly crenate to coarsely and irregularly dentate, the larger blades 2.5–4.5 cm. long and as wide or wider. Petioles slender or stout, ⅔–1 times as long as the blade. Inflorescence usually racemiform, at most subthyrsoid, relatively few-flowered. Pedicels slender or stout, much shorter than to twice as long as the calyx. Calyx at anthesis 8–15 mm. high, sometimes nearly as high as the corolla, with lanceolate or ovate-lanceolate, attenuate-acuminate lobes 1–2 times as long as the tube. Petals grenadine-pink, 13–25 mm. long. Column pubescent or glabrescent. Fruit hemispherical, about ⅖ as high as the calyx. Carpels (pl. 10, *E*) about 18, with chartaceous walls, about 4 mm. high, ⅗–⅔ as wide, very deeply notched (the depth of the notch nearly or quite equaling the width of the carpel at that point), the dehiscent portion erect, broadly deltoid with a very prominent beak, rounded at apex, muticous, the indehiscent portion forming about ⅖ of the carpel, prominently and rather coarsely reticulate, often nigrescent; attaching threads short and fragile, sometimes apparently wanting. Ovules 2 or 3. Seeds 1 or 2, sparsely pubescent.

Type locality.—Victoria, Texas, "margin of thickets on the prairie." Type (G) collected by F. Lindheimer in 1847–1848, No. 412.

Geographical distribution and habitat.—Southern Texas, near sea level to about 300 feet. Grows in sandy soil.

Specimens examined.—TEXAS. DeWitt County: Cuero, *Bray* 142 (N). Victoria County: Victoria, *Eggert* (M), *Lewton* 81 (N), *Lindheimer* 412, the type collection (G, M). Atascosa County: *Bogusch* 698 (N). Leming, *Schulz* 92 (N). Pleasanton, *E. J. Palmer* 9769 (M, N, S). Refugio County: Refugio, *Benke* 5395 (F). San Patricio County: Aransas Pass, *Schulz* 874 (N). Sinton, *Schulz* 2067 (F). Nueces County: Corpus Christi Bay, *Heller* 1540 (C, G, N). Kleberg County: Riviera, *Harrison* in 1930 (N). Willacy(?) County: Katherine, *York* 220 (S). Cameron County: *Bailey* 239 (N). Hidalgo County: *Runyon* 891 (N). (?) County: Pena, *Nealley* 53 (F). Matamoros to Goliad, *Berlandier* 994 (G, M). Without locality, *Berlandier* 557 (G, M).

This species shows no near relationship to any other. In the shape and coarse reticulation of the carpels it somewhat resembles *S. ambigua* Gray, but there is no other similarity and these species are widely separated, geographically. *S. lindheimeri* differs from all other North American species (except, occasionally, *pedatifida*) in the relatively great length of the hairs of the stems, leaves, and calyx.

12. **Sphaeralcea laxa** Woot. and Standl., Bull. Torrey Club, 36:108, 109. 1909.

S. incana dissecta Gray, Pl. Wright., 1:21. 1852.

S. ribifolia Woot. and Standl., Bull. Torrey Club 36:109, 110. 1909.

Plant perennial, with a thick, woody crown and a stout taproot, usually densely whitish canescent or tomentose with short hairs, those of the stem 0.2–0.3 mm. long, with 8–18 rays. Stems several, erect or ascending, up to 90 cm.

long, usually slender (less than 3 mm. in diameter at base). Leaf blades usually thin but sometimes thickish, flat, with veins only slightly prominent beneath, broadly ovate or deltoid in outline, at base subcordate to deeply cordate with an open sinus (seldom truncate), at apex very obtuse to acutish, 5-veined from the base, shallowly 3-lobed to almost 3-parted, with the lateral lobes sometimes deeply cleft, the lobes usually rounded, the mid-lobe seldom more than twice as long as the lateral ones, margin irregularly crenulate, crenate, or coarsely dentate, the larger blades 1.5–5 cm. long and approximately as wide. Petioles slender, those of the lower leaves usually equaling or longer than the blade. Inflorescence an open, lax, relatively few-flowered panicle. Pedicels slender, usually much shorter than the calyx. Bractlets of the involucel often dark red and conspicuous. Calyx at anthesis 7–11 mm. high, with lanceolate or oblong-lanceolate, acuminate lobes 1½ to 2½ (rarely 5) times as long as the tube. Petals grenadine-pink to grenadine-red, 12–18 mm. long. Anthers dark purple, drying nearly black, filaments and pistils red. Column more or less pubescent. Fruit truncate-ovoid, ⅗ as high as to nearly equaling the calyx. Carpels (pl. 10, *F*) 12–14, thin-walled, 4–6 mm. high, about ½ as wide, broadly and shallowly notched, the dehiscent portion erect, ovate or deltoid-ovate, acutish or sometimes obtuse at apex, cuspidate with cusps up to 1 mm. long, seldom only mucronate or mucronulate, the indehiscent portion forming ⅕–⅖ of the carpel, rather prominently but finely reticulate, with nearly transparent areolae; attaching threads well developed but usually short. Ovules 2 or 3. Seeds 1–3 (usually 2), pubescent, usually copiously so.

Type locality.—Frisco, Catron County, New Mexico. Type (NM) collected by E. O. Wooton, July 25, 1900.

Geographical distribution and habitat.—El Paso, Texas, to Arizona and northern Sonora, chiefly in southwestern New Mexico and southeastern Arizona, at elevations of 2000–6000 feet. Inhabits upland plains and foothills, preferring well-drained, shallow soil underlain by lime hardpan.

Specimens examined (selected).—TEXAS. El Paso County: El Paso, *Jones* 3745 (CA). El Paso(?) County: *Wright* 60 (G).

NEW MEXICO. Catron County: Graham, *Wooton* in 1900 (N). Frisco, *Wooton* in 1900, the type collection (NM). Grant County: Burro Mountains, *Greene* 253 (G). Plains of the Gila, *Greene* 12783 (M). Martin and Sloan Ranch, *Wooton* in 1902[80] (NM). Hidalgo County: Big Hatchet Mountains, *Mearns* 80 (N). Lordsburg, *Gillespie* 5315 (C, S). San Luis Mountains, *Mearns* 2104 (S, Y). (?) County, *Wright* 885[81] (G, M, N, Y).

ARIZONA. Navajo County: Holbrook, *Zuck* in 1896 (N). Coconino County: Williams, *Barber* 79 (N). Greenlee County: Clifton, *Davidson* in 1899 (S). Graham County: Camp Grant, *Palmer* 18 (M), Mount Graham, *Thornber and Shreve* 7894 (A). Pinal County: Florence, *Harrison and Kearney* 6653 (N, Y). Florence to Oracle, *Peebles* 6837 (F, Y). Maricopa, *Lemmon* 592 (G). Oracle Junction, *Peebles* 6657 (CA). Picacho Mountain, *Peebles* 6478 (N). Sacaton, *Harrison and Kearney* 6509A (N, Y). Cochise County: Benson, *Peebles*, 5896 (N). Bowie, *Rothrock* 328 (F, G, N), *Lemmon* 520 (G). Chiricahua Mountains, *Blumer* 1806 (A, F, G, M, N, S, Y), *Goodding* 2354 (C, R), *Lemmon* in 1881 (C), *Peebles and Loomis* 5880 (N). San Simon Valley, *Price* in 1894 (S). Pima County: Colossal Cave, *Jones* 26335 (M, P), *Fosberg* 7761 (C, P). Roadside Mine, *Harrison and Kearney* 8666 (F, N). Santa Catalina Mountains, *Eastwood* 17737 (CA), *Lemmon* 520 (C), *Pringle* in 1881 (G). Tucson, *Eastwood* 8135 (CA), *Griffiths* 2083 (Y), *Jones* 28245 (C, M), in 1903 (P, S, Y),

[80] Type collection of *S. ribifolia* Wooton and Standley.
[81] Type collection of *S. incana dissecta* Gray.

Lemmon 17 (G), *Parry* in 1852 (M), *Pringle* in 1881 (F, N), *Rose, Standley, and Russell* 15053 (N, Y), *Shreve* 4991 (C, CA), *Toumey* 73 (A, CA, N, S), *Vasey* in 1881 (F, G, N), *Zuck* in 1896 (C, M, N, Y).

Sonora. Niggerhead Mountain, *Mearns* 1886 (N), 1920 (N).

An exceptionally well-marked species that reaches its maximum abundance in and around Tucson, Arizona, where it is by far the most common member of the genus. The type specimen of *S. ribifolia* Woot. and Standl. is more representative of the species, as a whole, than is the type specimen of *laxa*. Jones' collection (No. 3745) at El Paso, Texas, marks the eastern limit of the known range and this seems to be an isolated station, as the species apparently has not been collected in the adjacent part of New Mexico (Dona Ana County). The collections at Holbrook and Williams, by Zuck and Barber, respectively, are the only ones from northern Arizona and the localities, as given on the labels, may be erroneous. Zuck's specimen closely resembles others collected by her in the same year at Tucson. Specimens collected along the Gila River, near Sacaton, Arizona, at a lower altitude than that at which the species commonly occurs, were doubtless strays from higher country, brought down by flood water.

Wright's No. 885, the type of *Sphaeralcea incana dissecta* Gray, is a depauperate form with small, deeply cleft or parted leaves. It probably represents a late-season stage, as very similar specimens have been collected in autumn, by the writer and others, in the vicinity of Tucson.

Specimens having leaf blades with a more elongate mid-lobe and subcuneate base, collected in the Chiricahua Mountains, Arizona, by Blumer (A) and by Harrison and Kearney (No. 6214, Sac), suggest hybridization with *S. fendleri* Gray. Indications of hybridization with *S. rusbyi* Gray are mentioned under the latter species (subsp. *gilensis*).

13. **Sphaeralcea rusbyi** Gray, Proc. Am. Acad., 22:293. 1887.

Plant perennial, with a thick, woody crown, sometimes spreading by root shoots, green and sparsely pubescent with rather stiff hairs, or glabrescent, hairs of the stem usually about 0.4 mm. long, with 5–11 rays. Stems several, erect or ascending, up to 85 cm. long, slender, rarely more than 3 mm. in diameter at base. Leaf blades thin and flat, with veins only moderately prominent beneath, broadly ovate, deltoid or nearly orbicular in outline, at base subcordate to deeply cordate with an open sinus, at apex acute to truncate and often mucronate, 5-veined from the base, pedately parted or divided, the divisions cuneate-obovate or oblanceolate and pinnately few-cleft or coarsely toothed, the mid-lobe 1–3 mm. wide at base and 1½–2 times as long as the lateral divisions, the larger blades 1.5–3 cm. long and about equally wide. Petioles slender, those of the lower stem leaves usually nearly or quite as long as the blade. Inflorescence relatively few-flowered, usually narrow and loosely subthyrsoid but sometimes more openly paniculate, with the lower branches up to 6 cm. long. Pedicels slender, usually much shorter than the calyx. Bractlets of the involucel often dark red and conspicuous. Calyx (especially the tube) usually conspicuously more pubescent than the stems and leaves, at anthesis 6–10 mm. high, with lanceolate to deltoid, usually acuminate, lobes 1–2½ times as long as the tube. Petals grenadine, 10–20 mm. long. Anthers usually purple but sometimes yellow or cream-colored. Column more or less

pubescent. Fruit truncate-ovoid, somewhat lower to somewhat higher than the calyx. Carpels (pl. 10, *G*) 10–12, with chartaceous walls, 4–5 (rarely 6) mm. high, ½–⅗ as wide, very shallowly and usually rather broadly notched, the dehiscent portion erect, ovate or deltoid-ovate, very obtuse or sometimes acutish at apex, usually muticous or mucronate but sometimes cuspidate with cusps up to 1 mm. long, the indehiscent portion forming ⅕–⅖ of the carpel, finely and often rather faintly reticulate; attaching threads often rather long. Seeds 2, usually pubescent, often copiously so.

Type locality.—Prescott, Yavapai County, Arizona. Type (Y) collected by H. H. Rusby in May, 1883, No. 537.

Geographical distribution and habitat.—Southwestern Utah to south-central Arizona, at elevations of 3000–6000 feet, on well-drained slopes, often, at the higher elevations, in openings in yellow-pine forests.

Specimens examined.—UTAH. Washington County: Springdale, *Jones* 5238 (C, F, M, N, P, R, S, Y). Zion Canyon, *Ballou* in 1924 (S). Zion National Park, *Eastwood and Howell* 1158 (CA, N).

ARIZONA. Coconino County: Grand Canyon, *Eastwood* 6052 (CA). Coconino (?) County: Little Colorado River, *Fernow* in 1896 (N). Yavapai County: Mayer, *Griffiths* 4890 (N). Prescott, *Rusby* 537, the type collection (F, G, Y), *Eastwood* 8843 (CA), 17693 (CA), *W. W. Jones* 280 (G), *Wooton* in 1911 (N), *Peebles, Harrison, and Kearney* 8845 (F, N), *Coues and Palmer* 358 (M). Prescott (?), *Palmer* 813 (N). Rio Verde, *Coues and Palmer* 489 (M). Gila County: Globe, *Eastwood* 8637 in part (CA), 8641a (CA). Mazatzal Mountains, *Eastwood* 17093 (CA, N), *Harrison* 7808 (N). Miami, *Kearney and Smith* 9016 (N, Y). Natural Bridge, *Chamberlain* 51 (N). Packard to Payson, *Eastwood* 17180 (CA). Sierra Ancha, *Eastwood* 16965 (CA, G). Pinal Mountains, *Gillespie* 5683 (C, N, Y). Maricopa County: Mormon Flat, *Peebles* 1001 (N). Graham County: Coolidge Dam, *Kearney and Smith* 9024 (N). San Carlos, *Ethel Palmer* in 1932 (CA). Pinal County: Ray to Hayden, *Harrison and Hope* 8465 (N). Ray to Winkelman, *Peebles, Harrison, and Kearney* 5165 (N).

This species, in its typical form, is very well marked. A specimen collected by Fernow on the Little Colorado River, Arizona, and part of Jones' collection at Springdale, Utah (No. 5238, R), are much more pubescent than usual and have an exceptionally small calyx. Their characters suggest hybridization with *S. grossulariaefolia* (H. and A.) Rydb. A specimen collected on the Gila River between Ray and Hayden, Arizona (*Harrison and Hope* 8465), has remarkably high and narrow carpels (6 mm. high and less than ½ as wide) that are prominently although very finely reticulate. The plant may be *rusbyi* × *laxa*, although it has typical *rusbyi* pubescence.

13*a*. **Sphaeralcea rusbyi gilensis** subsp. nov.

A formâ typica *S. rusbyi* pilis saepe brevioribus, caulibus plerumque longioribus et validioribus, laminis foliorum majoribus minus distincte pedatis lobis latioribus, inflorescentia plerumque longiori saepe laxiori, floribus pluribus plerumque majoribus, fructu calyce plerumque distincte breviori, distinguitur.

Differs from typical *rusbyi* also as follows: stems up to 100 cm. long, up to 5 mm. in diameter at base; pubescence of stems and leaves often more copious, the hairs often softer and more variable in length and number of rays, those of the stem 0.2–0.6 mm. long, with 4–17 rays; leaf blades 3–5 cm. long, usually deeply cleft or parted but sometimes rather shallowly lobed, the mid-lobe 4–15

mm. wide at base; inflorescence with the lower branches up to 12 cm. long; calyx at anthesis 9–14 mm. high; petals 14–20 mm. long; fruit sometimes only ⅔ as high as the calyx; carpels usually more numerous, often 15, more frequently cuspidate and prominently reticulate.

Type locality.—Devils Canyon, Pinal County, Arizona, at an elevation of about 4500 feet. Type (N) collected by T. H. Kearney and E. G. Smith, August 28, 1932, No. 9011.

Geographical distribution and habitat.—South-central Arizona, chiefly in and near the valley of the Gila River, usually at lower elevations than typical *rusbyi* (2000–5000 feet), on hillsides and the banks of streams.

Specimens examined.—ARIZONA. Yavapai County: Pine to Prescott, *Eastwood* 17621 (CA). Gila County: Globe, *Eastwood* 8637, in part (CA), 8641 (CA). Mazatzal Mountains, *Eastwood* 17251 (CA, G). Miami, Gillespie 8650 (C, N), *Harrison and Kearney* 6338 (N), 6339 (N), *Kearney and Smith* 9015, etc. (N). Winkelman, *Harrison* 8463 (N), *Harrison and Kearney* 6694 (N), 6695 (Y), *Peebles, Harrison, and Kearney* 5177 (N). Maricopa County: Camp Creek, *Harrison* 6611 (N). Fish Creek, *Peebles and Harrison* 5285 (N). Graham County: Coolidge Dam, *Eastwood* 16626 (CA), *Kearney and Smith* 9027 (F, N), 9028, etc. (N). Pinal County: Devils Canyon, *Harrison* 8698 (N), 8699 (N), *Kearney and Smith* 9011, the type collection (N). Florence, *Thornber* in 1909 (A). Kelvin, *Harrison and Kearney* 6696 (N). Mescal Mountains, *Jones* in 1890 (P). Ray, *Harrison* 8467 (N, Y), 8468 (N). Ray to Hayden, *Harrison* 8464 (N). Sacaton, *Harrison* 1859 (Sac), 8693 (N). Superstition Mountain, *Harrison* 6602 (N), *Peebles, Harrison and Kearney* 3720 (N).

An excessively variable form, of difficult characterization. At one extreme, represented by a specimen collected near Miami, Arizona (*Harrison and Kearney* 6638), the adult leaves are scarcely at all lobed, there being in this specimen apparently a persistence of the form normal in *rusbyi* for the first seedling leaves above the cotyledons (pl. 5). The affinity of this specimen would scarcely have been suspected but for the facts that it had good *rusbyi* carpels and grew with specimens that had more incised leaves. At the other extreme, there is such complete intergradation with typical *rusbyi* that the assignment of many specimens to one or the other form is largely arbitrary.

Much of the variation may be the result of hybridization with other species. Unpublished cytological observations by J. M. Webber point in this direction. Many of the specimens referred to subsp. *gilensis* differ from *S. laxa* Woot. and Standl. in their sparser pubescence of longer and fewer-rayed hairs, as well as in their contracted inflorescence, but specimens of more or less intermediate character are not infrequent, especially along the Gila River, in northeastern Pinal and southwestern Gila County, Arizona, where the ranges of these species almost or quite overlap. Similar specimens (*Harrison* 1859, 8693) were found in the Gila River bottoms near Sacaton (elevation 1300 feet), where doubtless they had grown from seeds brought downstream by flood waters. Other specimens from the Pinal Mountain-Gila River district (*Harrison* 8699, *Harrison and Kearney* 6696) characterized by short pubescence, an exceptionally narrow and many-flowered inflorescence, small calyx, and exceptionally broad carpels, may have resulted from hybridization with *S. grossulariaefolia* (H. and A.) Rydberg, subsp. *pedata,* although differing from the latter in their sparse pubescence.

13b. Sphaeralcea rusbyi eremicola (Jepson) comb. nov.

S. eremicola Jepson, Man. Fl. Pl. Cal., 635. 1925.

Differs from typical *S. rusbyi* as follows: calyx larger, 11–14 mm. high, its lobes relatively longer, about 3 times as long as the tube; fruit only about ½ as high as the calyx. From subsp. *gilensis,* this form differs in its more deeply and narrowly lobed leaves and more deeply cleft calyx.

Type locality.—Emigrant Canyon, Panamint Mountains, Inyo County, California, at an elevation of 4200 feet. Type (J) collected by W. L. Jepson, May 22, 1917, No. 7120.

Geographical distribution.—Known only from the type locality.

Specimens examined.—CALIFORNIA. Inyo County, Emigrant Canyon, Panamint Mountains, *Gilman* in 1934 (N), *Jepson* 7120, the type collection (J).

The writer could find none but the foregoing characters to distinguish this form from typical *rusbyi* although, geographically, *eremicola* is widely separated from the known range of *rusbyi.* The fruit of the type specimen is rather immature and, at maturity, may attain a greater height relative to the calyx. The calyx is much more densely pubescent on the tube than on the lobes, but this is frequently so also in typical *rusbyi* and in subsp. *gilensis.* The carpels are very like those of the type specimen of *rusbyi.* In Gilman's specimen the pubescence is shorter than in the type and the carpels are short-cuspidate.

14. Sphaeralcea wrightii Gray, Pl. Wright, 2:21. 1853.

Plant perennial, with a rather small, woody crown, grayish canescent or subtomentose with soft hairs, those of the stem 0.25–0.40 mm. long, with 11–17 rays. Stems few, erect or nearly so, up to 75 cm. long, up to 4 mm. in diameter at base. Leaf blades thickish with veins rather prominent beneath, much more densely pubescent on the lower surface, broadly ovate to semiorbicular in outline, at base truncate to deeply cordate, at apex usually obtuse and often mucronulate, 3–5-veined from the base, all but the lowest pedately deeply cleft or parted, the divisions wedge-shaped and coarsely, irregularly, and pinnately few-toothed or cleft with broad usually obtuse teeth, the mid-lobe 2–2½ times as long as the lateral lobes, larger blades 2–4 cm. long and ⅔ to quite as wide. Petioles rather slender, those of the lower leaves usually as long as to much longer than the blade. Inflorescence a narrow, few- to many-flowered, interrupted thyrse. Pedicels rather stout, shorter to considerably longer than the calyx. Calyx at anthesis 6–7 mm. high, with deltoid-ovate or ovate-lanceolate, short-acuminate lobes equaling or slightly longer than the tube. Petals grenadine, or pink, often drying lavender or violet, 10–18 mm. long. Anthers purple. Column sparsely pubescent. Fruit truncate-conical, equaling to considerably surpassing the calyx. Carpels (pl. 10, *H*) 12–15, with chartaceous walls, sometimes slightly connate at maturity, 4–5 mm. high, about ⅗ as wide, very shallowly notched, the dehiscent portion erect, broadly ovate or deltoid with a prominent ventral beak, very obtuse to acutish at apex, cuspidate, the indehiscent portion forming ⅓–⅖ of the carpel, prominently and rather coarsely. or rather finely reticulate; attaching threads long, stout and persistent. Seeds 2, copiously pubescent.

Type locality.—"On a mountain near Lake Santa Maria," northwestern Chihuahua. Type (G) collected by C. Wright in April, 1852, No. 1330.

Geographical distribution.—Western Texas to southeastern Arizona and northwestern Chihuahua, probably also in northeastern Sonora.

Specimens examined.—TEXAS. El Paso County, El Paso, *Vasey* in 1881 (F).

New Mexico. Dona Ana County: Rincon, *Jones* in 1884 (P). Luna County: Carrizalillo Mountains and Springs, *Mearns* 75[32] (G, N, Y), 79 (N, S, Y). (?) County: without locality, *Wright* in 1852 (G), *Mexican Boundary Survey*[33] (N).

Arizona. Graham County: Fort Grant, *Palmer* 19 (M), 20 (M), 22 (M). Cochise County: Douglas, *Carlson* in 1915 (CA, N). Sulphur Springs Valley, *Price* in 1894 (S).

Chihuahua. Laguna de Santa María, *Wright* 1330, the type collection (G, M, N), *Bigelow* 111 (Y). Madera, *Palmer* 265 (Y). Ojo de Vaca, *Thurber* 313[34] (G, Y).

This species is still imperfectly known, although very distinct and well marked as represented by the type collection. Most of the other specimens referred here have no fruit and are too imperfect to afford the basis of a satisfactory description. In leaf shape, Carlson's and Price's specimens somewhat resemble forms of *S. laxa* Woot. and Standl. with deeply dissected leaves, but are readily distinguished from the latter species by their contracted inflorescence and longer, looser pubescence. Vasey's collection at El Paso, Texas, and Palmer's collections at Fort Grant, Arizona, are referred very doubtfully to *wrightii*.

15. **Sphaeralcea incana** Torrey, *in* Gray, Mem. Am. Acad., n. ser., 4:23. 1849.

Plant perennial, with a stout, woody crown and a large taproot, very densely yellowish canescent with very short scurfy hairs, those of the stem 0.1–0.2 mm. long and with 9–20 rays. Stems several or many, erect, tall, up to 180 cm. long, and stout, up to 6 mm. in diameter at base. Leaf blades usually rather thick and with veins prominent beneath, deltoid-ovate, at base usually truncate or subcordate with a very open sinus, at apex usually very obtuse or slightly retuse and often mucronulate (seldom acutish), usually strongly 5-veined from the base, scarcely lobed to very shallowly 3–5-lobed, usually at or near the middle, with broad, rounded lobes, the mid-lobe seldom less than 5 times the length of the lateral lobes, margin usually crenulate but sometimes irregularly and rather coarsely crenate or dentate, the larger blades 3–7 cm. long, ⅔ as wide to somewhat wider than long. Inflorescence a long, narrow, interrupted, very many-flowered thyrse, the lower branches seldom more than 3 cm. long. Pedicels rather slender but exceptionally tough and persistent, from considerably shorter to considerably longer than the calyx. Bractlets of the involucel thickish, not becoming red or purple. Calyx at anthesis 3.5–6.5 mm. high, with deltoid-ovate to ovate-lanceolate, acute or short-acuminate lobes ⅔–2 times as long as (usually equaling) the tube. Petals grenadine-pink, 10–17 mm. long, often well separated at base. Column usually 6 mm. long or longer, more or less pubescent. Fruit truncate-conical, nearly equaling to considerably surpassing the calyx. Carpels (pl. 10, *I*) 11–14, with chartaceous walls, usually not connate at maturity, 4–5 mm. high, ½–⅗ as wide, usually shallowly and broadly notched, the dehiscent portion erect, ovate, very obtuse to acutish and cuspidate, with spreading or ascending, stout cusps up to 2.0 mm. long, the indehiscent portion forming ⅕–⅖ of the carpel, faintly or rather prominently and usually finely reticulate; attaching

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[32] One specimen of this collection (Y) is labeled as from Las Palomas, Chihuahua, only a few miles from Carrizalillo Springs.

[33] Possibly part of Bigelow's collection at Laguna de Santa María, Chihuahua.

[34] One of the specimens of this number in the Gray Herbarium is labeled as from Las Playas, Sonora.

threads tough and very persistent, usually long. Seeds 2, usually rather sparsely pubescent or glabrescent.

Type locality.—"In New Mexico." Type (Y) collected by Abert in 1846.

Geographical distribution and habitat.—Western Texas and New Mexico to northeastern Arizona, northern Chihuahua, and northeastern Sonora, at elevations of 3500–6000 feet. Grows on sandy or gravelly mesas and slopes, usually in the open but occasionally among pinyons and junipers.

Specimens examined.—TEXAS. Culberson County: Guadalupe Mountains, *Havard* in 1881 (N), *Moore and Steyermark* 3789 (C, G, M). Plateau, *Kearney and Harrison* 25 (N). Hudspeth County: *Cory* 2042 (N), Nullo to Harris Siding, *Ferris and Duncan* 2450 (CA, M, S, Y). El Paso County: El Paso, *Clark* 4303 (M), *Schulz* 231 (N), *Stearns,* 53 (N). San Elizario, *Wright* 59 (C, G, N), *Mexican Boundary Survey* in 1852 (Y). Jeff Davis County: Davis Mountains, *Hanson* 44B (G, N). Fort Davis, *Cory* 2043 (N), *Girard* in 1880 (G), *Young* 1671 (N). Brewster County: Alpine, *Fisher* 32266 (F), *Orcutt* 1172 (N). Presidio County: Chinati Mountains, *Nealley* 55 (F).

NEW MEXICO. Santa Fe County: Santa Fe, *Kearney and Leding* 13 (N, Y). Sandoval County: San Ysidro, *Arsène* 19022 (N). Bernalillo County, Albuquerque, *Munson and Hopkins* in 1889 (N). Valencia County: Los Lunas, *Kearney and Leding* 14 (N). Valencia(?) County: Albuquerque to Gallup, *Eastwood* 15678 (CA). Lincoln County: west of Roswell, *Earle* 505 (N, Y). White Mountains, *Wooton* 380 (C, G, M, N, P, S, Y). Socorro (or Dona Ana) County: Jornada del Muerto, *Wislizenus* 44 (M), 55 (M). Otero County: Hueco, *Mulford* 168 (M, Y). Jarilla Junction, *Earle* (Y). White Sands, *Wooton* 556 (Y), in 1904 (N). Dona Ana County: El Paso to Monument 6, *Wagner* 911 (N, S, Y). Organ Mountains, *Arthur and Fromme* in 1914 (N), *Wooton* 439 (A, M, N, Y), *Wooton* in 1894, 1902, and 1904 (C, N, P, S, Y), *Wooton and Standley* 3177 (N), in 1906 (N), in 1907 (M). Strauss to Anapra, *Stearns* 381 (N). Luna County: Deming, *Kearney and Leding* 3 (N), 4 (N). Hidalgo County: San Luis Mountains, *Mearns* 2104, in part (N). Without locality, *Abert* in 1846, the type collection (F, Y).

ARIZONA. Navajo County: Hopi Country, *Owens* 21 (G).

CHIHUAHUA. Juarez, *Stearns* in 1912 (M). Laguna de los Patos, *Thurber* 816 (G). San Pedro, Sierra Madre Mountains, *Jones* in 1903 (P).

SONORA. Fronteras, *Hartman* 44 (G, N, Y).

This is one of the tallest of the North American species, of striking appearance with its wand-like stems and light yellowish-green color. The petals are more widely separated toward the base than in most of the species. In the field, it appears much more distinct from the nearly related *S. fendleri* Gray than comparison of the descriptions would indicate. *S. incana* commonly inhabits treeless plains and slopes, while *fendleri* is normally a woodland species.

S. incana is relatively little variable, but two aberrant forms are worth noticing. One, collected in the Organ Mountains, New Mexico (*Arthur and Fromme, Wooton, Wooton and Standley*), near El Paso, Texas (*Stearns*), and in the San Luis Mountains, New Mexico (*Mearns*), resembles *S. fendleri albescens* in the thinner and more lobate leaves and whitish rather than yellowish pubescence. The leaf blades, however, are truncate or cordate rather than cuneate at base. A somewhat similar specimen from Fronteras, Sonora (*Hartman* 44), is aberrant also in its long-branched inflorescence.

Another form, typical in pubescence but with leaf blades more elongate and tapering than usual, seems to be rather frequent in western Texas, where it was collected in the Guadalupe Mountains (*Havard* in 1881), in Hudspeth County (*Cory* 2042), at Fort Davis (*Young* 1671), at Alpine (*Orcutt* 1172, *Fisher* 32266), in the Chinati Mountains (*Nealley* 55), and at San Elizario (*Mexican Boundary Survey*). These specimens somewhat resemble subspecies *cuneata,* but the leaf blades are usually not or but slightly cuneate at base.

15*a.* **Sphaeralcea incana cuneata** subsp. nov.

A forma typica *S. incanae* laminis foliorum angustioribus oblongo-ovatis vel ovato-lanceolatis plerumque basi conspicue cuneatis et apice acutis vel acutiusculis plerumque trinervatis prope basim trilobatis lobis brevibus, petiolo plerumque multo breviori, distinguitur.

Differs from typical *S. incana* as follows: stems even taller and stouter, up to 210 cm. long and 10 mm. in diameter at base; leaf blades ⅓–⅔ as wide as long, usually only 3-veined from the base (if 5-veined, the extra veins much smaller), the mid-lobe seldom less than 6 and sometimes 20 times as long as the lateral lobes; petioles of the lower leaves usually less, often much less, than ½ as long as the blade; inflorescence often longer than in the typical form, sometimes 110 cm. long; carpels frequently acutish at apex, usually cuspidate but sometimes muticous.

Type locality.—Los Lunas, Valencia County, New Mexico. Type (N) collected by H. H. Rusby, July 15, 1880, No. 89.

Geographical distribution and habitat.—Northwestern New Mexico and northeastern Arizona, at elevations of 4000–5000 feet, in sandy soil on open mesas, frequent at roadsides.

Specimens examined.—New Mexico. Sandoval County: Algodones, *Tracy and Evans* 140 (Y), *Kearney and Leding* 35 (N, Y). Bernalillo County: Albuquerque, *Herrick* in 1894 (N). Valencia County: Acoma, *Ballou* in 1924 (S). Laguna, *Wooton* in 1906 (N, NM). Los Lunas, *Rusby* 49a (M, Y), 89, the type collection (C, F, M, N), *Kearney and Leding* 15 (F, N, Y), 16 (N), 17 (N), 18 (N). Rio Puerco, *Kearney and Leding* 19 (F, N), 24 (N). McKinley County: Ojo Caliente, *Wooton* 2678 (N). Zuni Reservation, *Stevenson* 6 (N), 31 (N), 76 (N).

Arizona. Apache County: Adamana, *Griffiths* 5171 (N). St. Johns, *Griffiths* 5179 (N). Navajo County: Holbrook, *Zuck* in 1896 (F, N, Y). Coconino County: Tuba City, *Clute* 113 (F, G, M, N).

This subspecies approaches *S. fendleri* Gray in its relatively narrow and cuneate leaf blades, but is distinguished by its yellowish pubescence. The writer saw subsp. *cuneata* growing with typical *incana* at Los Lunas, New Mexico, and, nothwithstanding the very different leaf shape, the close affinity of the two forms could not be doubted, especially as specimens of intermediate character, also, were collected at that locality (*Kearney and Leding* 15). There is a resemblance between subsp. *cuneata* and the broad-leafed, more lobate form of *S. angustifolia* (Cav.) Don, but the latter is more coarsely and loosely pubescent and has the leaf lobes usually more angulate.

One of Rusby's collections at Los Lunas, New Mexico (No. 49a) has the leaf blades unusually deeply lobed and coarsely toothed. Specimens from Tuba City, Arizona (*Clute* 113), have the leaf blades exceptionally short and

broad for this form, 3/5 as wide as long. A similar specimen from northeastern Arizona but with still broader leaves (*Owens* 21) was cited under *S. incana* f. *typica*. Other specimens that seem more or less intermediate between typical *incana* and subspecies *cuneata*, cited under *incana*, are from considerably south and east of the known range of the subspecies, that is, from western Texas and Deming, New Mexico. Stevenson's specimens from the Zuni Reservation, New Mexico, and most of the Arizona specimens are less typical of the subspecies and seem to connect with *S. fendleri* Gray. They have narrower leaf blades and smaller, more pointed, subbasal lobes or teeth.

16. **Sphaeralcea fendleri** Gray, Pl. Wright, 1:21, 22. 1852.

S. miniata Gray, Mem. Am. Acad., n. ser., 4:19. 1849. Not *S. miniata* (Cav.) Spach.
S. leiocarpa Woot. and Standl., Bull. Torrey Club, 36:107, 108. 1909.

Plant perennial, with a woody crown, green and sparsely pubescent to densely grayish or whitish canescent with usually very short hairs, those of the stem 0.15–0.25 (rarely 0.4) mm. long, with 10–18 rays. Stems several, erect or ascending, up to 140 cm. long, usually slender but sometimes 8 mm. in diameter at base. Leaf blades thin or thickish, with veins prominent beneath, usually dark green above, lighter colored and often densely whitish canescent beneath, oblong-ovate to very broadly ovate, at base usually strongly cuneate, at apex acute to obtuse and often mucronulate, 3-veined (occasionally 5-veined) from the base, very shallowly to very deeply 3-lobed below the middle with relatively narrow, triangular or nearly rectangular, usually ascending and usually acutish lateral lobes 1/7–1/2 (usually about 1/4) as long as the mid-lobe, the latter sometimes coarsely and irregularly few-toothed or cleft, margin coarsely to finely crenate or crenate-dentate, the larger blades 3–6 cm. long and 2/5 to fully as wide. Petioles slender, those of the lower leaves usually less than 1/2 as long as the blade. Inflorescence a very narrow, interrupted, many-flowered thyrse, the lower branches not exceeding 3 cm. long and usually much shorter. Pedicels slender but very tough and persistent, usually equaling or longer than the calyx. Bractlets of the involucel thin, usually green. Calyx at anthesis 4.5–6 (rarely 9) mm. high, with usually deltoid and acute but sometimes ovate-lanceolate and short-acuminate lobes approximately as long as the tube. Petals grenadine or occasionally grenadine-pink (rarely mauve, drying violet), 8–13 mm. long. Column not more and often less than 6 mm. long, copiously pubescent to glabrescent. Fruit truncate-conical, equaling or (usually) surpassing the calyx. Carpels (pl. 11, *A*) 11–15, with chartaceous walls, often somewhat connate at maturity, 4–5 mm. high, usually about 3/5 as wide, very shallowly notched, the dehiscent portion erect, ovate, at apex usually very obtuse and cuspidate with cusps up to 1.2 mm. long, the indehiscent portion forming 1/5–1/3 of the carpel, usually faintly (sometimes almost imperceptibly) and very finely reticulate; attaching threads tough and persistent, usually long. Seeds 2, pubescent, usually copiously so.

Type locality.—Santa Fe, New Mexico. Type (G) collected by A. Fendler in 1847, No. 78.

Geographical distribution and habitat.—Southern Colorado, western Texas, New Mexico, and Arizona to Chihuahua and northern Sonora, at elevations of 3500–8000 (usually not below 5000) feet. Grows on banks and slopes, commonly in open places in yellow-pine forests but sometimes descending to the live-oak belt.

Specimens examined (selected).—COLORADO. Costilla County: Chama, *Biltmore Expedition* 6671a (N). Montezuma County, San Juan Valley, *Brandegee* 1089 (C), 4296 (M).

TEXAS. Culberson County: Guadalupe Mountains, *Moore and Steyermark* 3599 (C, G, M, Y).

NEW MEXICO. Rio Arriba County: Canjilon, *Wolf* 2928 (S). San Juan County: Navajo Reservation, *Standley* 7179 (N). San Miguel County: Las Vegas, *Cockerell* (N, Y). Pecos, *Standley* 4934 (CA, G, M, N). Santa Fe County: Canoncito, *Eastwood* 15486 (CA). Santa Fe, *Fendler* 78, the type collection (F, G, M, N, Y), *Heller* 3811 (A, G, M, N, P, S, Y). McKinley County: Agua Azul, *Rothrock* 116 (F, G). Bernalillo County: Albuquerque, *Jones* in 1884 (F), *Rose and Fitch* 17803 (M, N). Valencia County: Craters, *Wooton* in 1906 (N). Lincoln County: Gray, *Earle* 153 (M, N, Y). Socorro County: Socorro, *Vasey* in 1881 (N). Catron County: Mogollon Mountains, *Metcalfe* 465 (M, Y). Otero County: Tularosa Creek, *Wolf* 2799 (G). Sierra County: Kingston, *Metcalfe* 1019, 1020 (CA, F, G, M, N, P, Y). Grant County: Fort Bayard, *Blumer* 19, 47 (G, N, Y). Mangas Springs, *Metcalfe* 158 (A, CA, G, M, N, P, S, Y), 791[35] (A, G, M, N, NM, Y). Grant (or Luna) County: Rio Mimbres, *Wright* 884 (G, N), 886 (Y). Dona Ana County: Organ Mountains, *Wooton* in 1895 (N). Rincon, *Jones* in 1884 (P). Luna County: Ojo del Muerto, *Wislizenus* 72 (M).

ARIZONA. Apache County: Navajo Reservation, *Standley* 7488 (N). Navajo County: Fort Apache, *Palmer* 594 (G, N). Coconino County: Elden Mountain, *Purpus* 40 (C, N). Flagstaff, *Hanson* A245 (F, M, Y). *Wolf* 3101 (CA, G, S). San Francisco Mountains, *Leiberg* 5669 (G, N). Walnut Canyon, *Macdougal* 334 (A, C, F, G, N, Y). Yavapai County: Fort Whipple, *Coues and Palmer* 36 (M). Prescott, *King and Hope* 8785 (N), 8788 (N), *Kusche* in 1929 (C, CA), *Wolf* 2331 (CA, G, S). Greenlee County: Duncan, *Davidson* 1033 (C). Cochise County: Chiricahua Mountains, *Toumey* 12 (G, N). Pima County, Rincon Mountains, *Goodding* 19 (A).

CHIHUAHUA. Chihuahua, *Pringle* 985 (F, N, Y). Colonia Juarez, *Jones* in 1903 (P). Sapio, *Jones* in 1903 (P). Sierra en Media, *E. W. Nelson* 6479 (N).

SONORA, Cananea, *Donnelly* 18 (C), *Murdoch* in 1914 (F). Imuris, *Wiggins* 6200 (S).

S. fendleri is by far the most abundant representative of the genus in the yellow-pine belt of New Mexico and Arizona. It is exceedingly variable and must be regarded as a generalized form, intergrading, apparently, with *S. wrightii* A. Gray, *S. incana* Torrey, and *S. angustifolia* (Cav.) Don. Superficially, it bears some resemblance to the South American *S. miniata* (Cav.) Spach, to which the type collection (*Fendler* 78) was first referred by Gray, but the carpels are different, as will be seen by comparison of plate 11, *A, B* and plate 12, *L*.

Specimens collected in Chihuahua (*Pringle* 985, *Nelson* 6479) resemble *wrightii* in their deeply cleft, almost pedate, leaf blades, but are distinguished therefrom by their shorter pubescence and, in Pringle's specimens, by the less prominent and finer reticulation of the carpels. Several other specimens with very deeply cleft, parted or almost divided leaves, but not resembling *wrightii*, have been collected in New Mexico and Chihuahua, including part of the type collection (*Fendler* 78). In three of these collections, made by

[35] Type collection of *S. leiocarpa* Woot. and Standl.

Jones at Albuquerque and Rincon, New Mexico, and at Sapio, Chihuahua, the petals dried lavender or violet. A collection at Fort Bayard, New Mexico (*Blumer* 47), has nearly white petals. An extraordinary form, collected between El Paso, Texas, and Socorro, New Mexico (*L. B. Payson* 62), has leaves like *fendleri*, but the inflorescence is open and long-branched, the petals are purple, and the carpels are very coarsely and prominently reticulate for that species. The last character suggests that it may be *fendleri* × *wrightii*. A collection at Kingston, New Mexico (*Metcalfe* 1020), with very narrow leaf blades that are subhastately lobed, with very small, acutish lobes, bears a rather striking resemblance to some of the specimens referred to *incana cuneata*.

S. leiocarpa Woot. and Standl. was based on a collection at Mangas Springs, Grant County, New Mexico (*Metcalfe* 791). The principal character given by the authors to distinguish this form from *fendleri* is the almost complete absence of reticulation on the carpels, but the carpels of *fendleri* are seldom prominently reticulate and there is complete gradation to the very faint reticulation that characterizes the type collection of *leiocarpa*.

16*a*. Sphaeralcea fendleri elongata subsp. nov.

A forma typica *S. fendleri* laminis foliorum tenuioribus et minus pubescentibus longioribus angustioribus distinguitur.

Differs from typical *fendleri* also as follows: leaf blades 5–9 cm. long and 1/4–1/2 as wide, very shallowly lobed near the base, the lateral lobes usually much less than 1/5 as long as the mid-lobe.

Type locality.—In the White Mountains, Lincoln County, New Mexico, at an elevation of 7400 feet. Type (N) collected by E. O. Wooton and Paul Standley, August 25, 1907, No. 3559.

Geographical distribution and habitat.—New Mexico, apparently confined to the yellow-pine belt, at elevations of 5500–7500 feet. Inhabits open places in pine forests, along streams, etc.

Specimens examined.—New Mexico. Santa Fe County: Santa Fe, *Vasey* in 1889 (N). Sandoval (or Bernalillo) County: Sandia Mountains, *Ellis* 41 (M, N, Y). Lincoln County: Ruidoso River, *Eggleston* 18897 (N). White Mountains, *Wooton and Standley* 3559, the type collection (N, S), *Wooton* in 1895 (N). Otero County: Highrolls, *Eggleston* 14419 (G, N). Mescalero Reservation, *Kearney and Leding* 33 (N), *Wooton* in 1897 (N), in 1905 (N). Tularosa Creek, *Wooton* in 1899 (G, N, Y). Sacramento Mountains, *Wooton* in 1899 (N).

This form simulates *S. angustifolia lobata* in the shape of the leaf blades, but they are thinner and less pubescent. It is a plant of the mountains, whereas *lobata*, like all forms of *angustifolia*, is a plant of alluvial valleys, at lower elevations. Two collections cited under *S. fendleri* f. *typica* (*Moore and Steyermark* 3599, Guadalupe Mountains, Texas, *Standley* 4934, Pecos, New Mexico) approach this subspecies.

16*b*. Sphaeralcea fendleri albescens subsp. nov.

A forma typica *S. fendleri* laminis foliorum praecipue superficie inferiore subvelutinis pilis albis brevissimis plerumque tenuibus et latis lobis et dentibus obtusissimis distinguitur.

Type locality.—Along Sonoita Creek near Patagonia, Santa Cruz County, Arizona, at an elevation of about 3500 feet. Type (N) collected by G. J. Harrison and T. H. Kearney, October 23, 1932, No. 9092.

Geographical distribution and habitat.—Extreme southern Arizona and northern Sonora, inhabiting thickets along streams in the live-oak belt.

Specimens examined.—ARIZONA. Santa Cruz County: Nogales, *Harrison* 8178 (N), *Harrison and Kearney* 9075 (N, Y), 9075a (N). Patagonia, *Harrison and Kearney* 9092, the type collection (CA, N).

SONORA. Magdalena, *Orcutt* 1361 (N). Santa Cruz, *Mearns* 2634 (N), *Thurber* 921 (G, N, Y).

The carpels of this form vary considerably in size and shape, being sometimes exceptionally high (up to 6 mm.), narrow, and long-cuspidate, with cusps nearly 2 mm. long. The leaf blades, although usually thin and broad with rounded lobes and teeth, are sometimes thickish, with narrower and more angulate lobes.

16*c*. **Sphaeralcea fendleri tripartita** (Woot. and Standl.) comb. nov.

S. tripartita Woot. and Standl., Bull. Torrey Club, 36:108. 1909.

Differs from typical *S. fendleri* as follows: leaf blades truncate or subcuneate at base, very deeply 3-lobed, otherwise entire or nearly so, the lateral lobes very broad, very obtuse, forming nearly a right angle with the mid-lobe and ½–⅔ as long as the latter.

Type locality.—Kingston, Sierra County, New Mexico. Type (NM) collected by O. B. Metcalfe, July 10, 1904, No. 1103.

Geographical distribution.—Known only from the type locality.

Specimens examined.—NEW MEXICO. Sierra County: Kingston, *Metcalfe* 1103, the type collection (M, N, NM, Y).

It is questionable whether this form should be maintained even as a subspecies, in view of the great variability of *fendleri*. Although the peculiar leaf shape gives *tripartita* a strikingly different appearance from typical *fendleri*, there is close correspondence in all other characters. The fact that the material in herbaria all came from a single plant, described by the collector as a "bush 6 feet high," suggests that only an extreme individual variation may be involved. The only other specimen known to the writer that approaches *tripartita* in appearance was collected at Las Vegas, New Mexico (*Cockerell*, N). This is similar in having very deeply 3-lobed leaves with lateral lobes ½ as long as the mid-lobe, but the lateral lobes are ascending and all 3 lobes are usually coarsely few-toothed and narrowed toward the base. In Cockerell's specimen the stems and both surfaces of the leaf blades are covered with a dense, fine, silvery canescence, while in *tripartita* the leaf blades are bright green above and paler, but not conspicuously paler, beneath.

16*d*. **Sphaeralcea fendleri venusta** subsp. nov.

A forma typica *S. fendleri* pilis caulis et foliorum multo longioribus 0.6–0.8 mm. longis et solum 4–8-radiatis, floribus majoribus, petalis saepe 15–20 mm. longis plerumque purpureo-rosaceis, distinguitur.

Differs from typical *fendleri* also as follows: stems and leaves more conspicuously pubescent owing to the greater length of the hairs; leaf blades usually larger, up to 8.5 cm. long, at base usually more or less cuneate (as

in typical *fendleri*) but frequently truncate or subcordate; petals normally purplish pink, drying lavender or violet, but occasionally grenadine; column 6–8 mm. long; carpels (pl. 11, *B*) sometimes higher (up to 6 mm.) and usually narrower (about ½ as wide as high), otherwise as in the typical form.

Type locality.—"By streams of the Santa Catalina Mountains," Pima County, Arizona. Type (N) collected by C. G. Pringle in May, 1881.

Geographical distribution and habitat.—Southern Arizona and Chihuahua, at elevations of 4500–7000 feet. Grows in rich soil, usually in partial shade, near the lower edge of the yellow-pine belt, descending, along streams, to the live-oak belt.

Specimens examined.—ARIZONA. Graham County: Mount Graham, *Peebles, Harrison, and Kearney* 4399 (Sac), 4478 (Sac). *Thornber and Shreve* 7895 (A), 8013 (A). Cochise County: Chiricahua Mountains, *Toumey* 13 (G). Fort Rucker, *Lemmon* 519 (G). Rucker Valley, *Lemmon* in 1881 (F). Huachuca Mountains, *Jones* in 1903 (S), *Harrison and Kearney* 5782 (N). Pima County: Baboquivari Mountains, *Gilman* B16 (N), *Harrison* 4768 (N), 5827 (N), *Peebles* 557 (N). Rincon Mountains, *Blumer* 3358 (A, C, F, G, M, S). Santa Catalina Mountains, *Griffiths* 7163 (M), *Harrison and Kearney* 7449 (N), 8049 (N), 8136 (F, N), *Lemmon* 165 (C), *Munz* 1101 (P), *Peebles, Harrison, and Kearney* 2554 (N), *Pringle* in 1881, the type collection (F, G, M, N, Y). Santa Rita Mountains, *Harrison and Kearney* 8905 (N, Y), *Jones* in 1903 (P), *King and Loomis* 2900 (N), *Thornber* 74 (A, M, N, P, S, Y), *Wooton* in 1912 (N).

CHIHUAHUA.—Casas Grandes, *E. W. Nelson* 6331 (N). Santa Eulalia Mountains, *Wilkinson* in 1885 (N).

A handsome plant, with numerous stems terminating in long thyrses of large flowers, the petals usually of a clear mauve pink when fresh, with lemon-yellow or greenish claws, although the specimens from Mount Graham and the Huachuca Mountains, and several from the Chiricahua Mountains, have grenadine petals. The stems are often villous and the leaves velutinous. As in typical *fendleri,* there is great variation in the degree of dissection of the leaf blades. The specimens from Mount Graham, Arizona, have the blades very deeply 3-cleft (almost 3-parted) with narrow lobes that are, in turn, deeply cleft, the mid-lobe pinnately so. The leaf blades of these specimens are rather thick, very pubescent, and whitish beneath. The other extreme, probably a shade form, is represented by a specimen collected in the Baboquivari Mountains, Arizona (*Harrison* 4768), which has thin and not conspicuously pubescent leaf blades that are very shallowly lobed and rather regularly dentate. Another exceptionally thin-leafed specimen was collected at Casas Grandes, Chihuahua (*Nelson* 6331). This and Wilkinson's specimens from the Santa Eulalia Mountains, Chihuahua, have shorter pubescence than the others and in this respect they approach subsp. *albescens,* differing from the latter principally in their larger flowers.

The geographical distribution of *fendleri venusta* overlaps that of *S. wrightii* Gray, but these forms apparently do not intergrade. The longer, fewer-rayed hairs and the relatively smaller size and much fainter reticulation of the indehiscent portion of the carpel readily distinguish the former from the latter.

17. **Sphaeralcea angustifolia** (Cav.) Don, Hist. Dichl. Pl., 1:465. 1831.

Malva angustifolia Cav., Diss., 1:64, t. 20, fig. 3. 1786.

Sphaeroma angustifolium Schlecht, Linnaea, 11:353. 1837.

Sphaeralcea angustifolia violacea Davy, Erythea, 3:118. 1895.

Plant perennial, with a thick, woody crown, canescent, usually densely so, at least when young, the pubescence often becoming rather loose, hairs of the stem 0.3–0.5 mm. long, with 8–20 rays. Stems erect or nearly so, usually tall and rather stout, up to 180 cm. long, up to 5 (rarely 8) mm. in diameter at base. Leaf blades usually thickish, with veins more or less prominent beneath, lanceolate or oblong-lanceolate, at base cuneate, usually strongly so, tapering from near the base to a usually acuminate apex, 3-veined from the base, not lobed but often angulate near the base or subhastately toothed with acutish, ascending teeth, margin crenate or crenate-dentate, usually finely and regularly so, the larger blades 5–12 cm. long and 1/6–1/3 as wide. Petioles slender or rather stout, those of the lower leaves seldom more than 1/4 as long as the blade. Inflorescence a long, narrow, interrupted, many-flowered thyrse, conspicuously leafy nearly to the apex, the lower branches not more than 4 cm. long and usually much shorter. Pedicels usually stout and much shorter than the calyx. Calyx at anthesis 5–9 mm. high, with lanceolate or oblong-lanceolate and acuminate (seldom deltoid-ovate and merely acute) lobes 1–3 times as long as the tube. Petals usually mauve or lavender (often drying violet) but sometimes white or grenadine, 10–20 mm. long. Anthers usually purple but sometimes yellow. Column pubescent, often copiously so. Fruit truncate-conical, 2/3 as high to slightly higher (but usually lower) than the calyx. Carpels (pl. 11, *C*) 10–16, with chartaceous walls, usually strongly connate at maturity, 3.5–6.5 mm. high, 1/2–3/5 as wide, pronouncedly but not very deeply notched, the dehiscent portion erect, ovate, very obtuse or sometimes acutish at apex, muticous or mucronulate (sometimes short-cuspidate), sometimes sparsely spinulose dorsally toward apex, the indehiscent portion forming 1/10–4/10 of the carpel, very finely and usually not prominently (sometimes very faintly) reticulate; attaching threads long, tough and persistent. Ovules 2 or 3. Seeds 1–3, usually glabrous.

Type locality.—Mexico. Type (Madrid) collected by D. Palau.

Geographical distribution and habitat.—Southwestern Texas, southward to Vera Cruz, Puebla, México (D. F.), and Michoacán, at elevations of 3000–7000 feet. Grows chiefly at roadsides and the edges of fields.

Specimens examined (selected).—TEXAS. Tom Green County: San Angelo, *E. J. Palmer* 10321 (S). Jeff Davis County: *Ingram* 2825 (N). Val Verde County: Del Rio, *E. J. Palmer* 11072 (S), *Wooton* in 1913 (N). Terrell County: Feodora, *E. J. Palmer* 33511 (Y). Sanderson, *Hanson* 43 (N). Brewster County: Castellan, *E. J. Palmer* 34223 (M, N, Y). Presidio County: Marfa, *Hanson* in 1919 (M, Y). Bexar County: San Antonio, *Schulz* 511 (N). Kinney County: Pinto Creek, *Kearney and Harrison* 7 (N). Maverick County: Eagle Pass, *Hanson* 33 (G, N), *Jones* 28243 (C, M), *Schott* in 1852 (F). Webb County: Laredo, *Clark* 4067 (M), Eggert in 1901 (M). (?) County: Painted Cave on the Rio Grande, *Davy* 36[36] (C).

NUEVO LEÓN. Monterrey, *Arsène* et al. 6281 (G, N), *Seler* 1060 (B, G, N).

COAHUILA. Parras, *Endlich* 338 (B), *Purpus* in 1906 (C). Pena, *Purpus* 1044 (C). Saltillo, *Arsène* et al. 3403 (B, M, N), *Palmer* 52 (C, G, M, N, Y), 339–342 (C, M, N, Y). Torreon, *Purpus* 132 (C, M, N, P).

[36] Type collection of *S. angustifolia violacea* Davy. The type locality probably is in Val Verde or Kinney County.

CHIHUAHUA. Bachimba Canyon, *Pringle* 843 (N, Y). Chihuahua, *Palmer* 45 (B, M, N, Y).

SONORA. Cd. Obregón, *Seler* 4103 (B).

DURANGO. Durango, *Palmer* 16 (B, C, M, N, Y). Mapimí, *Palmer* 525 (M, N, Y). Santiago Papasquiaro, *Palmer* 443–445 (B, C, G, M, N, Y).

SAN LUIS POTOSÍ. San Luis Potosí (?), *Parry and Palmer* 85 (G, M, N).

ZACATECAS. Zacatecas, *Schumann* 576 (B).

VERA CRUZ. Jalapa, *Rose and Hough* 4333 (C, Y). Orizaba, *Botteri* 841 (G), 842 (N).

HIDALGO. Tula, *Rose and Painter* 8334 (N, Y).

QUERÉTARO. Querétaro, *Arsène* 10475 (N), *Gregg* 593 (G, M).

GUANAJUATO. Guanajuato, *Dugès* in 1897 (G). La Luz, *Joor* in 1884 (M).

JALISCO. Lake Chapala, *Lemmon* 164, in part (C).

TLAXCALA. Santa Ana Tlaxcala, *Arsène* 5314 (N).

MÉXICO (Distrito Federal). *Bourgeau* 33 (B, G, N), *Schumann* 360 (B, G, N), *Pringle* 9439 (B, G, N), 11935 (B, G, N).

MICHOACÁN. Morelia, *Arsène* 5435 (G, M, N, Y).

PUEBLA. Puebla, *Arsène* 2220 (M, N), *Gregg* 234 (B), *Nicolas* in 1910 (C, CA, G).

This, the most southern ranging of the North American species of *Eusphaeralcea,* shows relatively little variation, notwithstanding its extensive geographical distribution. There is far less diversity in leaf shape than in *fendleri,* for example. The plant is easily recognized by its relatively long and narrow leaves, that are more regularly and finely crenate or dentate than are those of any other North American species; also by the upper leaves of the inflorescence, that are more developed and less bract-like than are those of most of the species. The carpels are usually so strongly connate as to be difficult to separate without tearing, even after complete dehiscence. Often the whole series of carpels separates from the upper part of the receptacle in a ring that is held to the base of the receptacle by the tough, persistent attaching threads, long after the upper seeds have been discharged.

The type of *S. angustifolia violacea* Davy, collected at Painted Cave, Texas (*Davy* 36), has mauve-colored petals drying violet, but is rather narrow-leafed, approaching in this respect subspecies *cuspidata.* Similar specimens were collected at other localities in Texas, in Jeff Davis County, and at Pinto Creek and Eagle Pass, by Ingram, by Kearney and Harrison, and by Jones, respectively. Several of the Mexican specimens, also, approach *cuspidata.* One from the Federal District, Mexico (*Pringle* 11935), has the carpels much larger than those in any other specimen examined (6.5 mm. high) and they are exceptional also in the rather prominent ventral beak. Collections in Texas by Hanson, at Marfa and Sanderson, and by E. J. Palmer at Feodora have grenadine petals, but all other Texas specimens examined by the writer have petals that dried purple. Hanson's specimen from Sanderson is exceptionally pubescent, almost tomentose.

17a. **Sphaeralcea angustifolia cuspidata** Gray, Proc. Am. Acad., 22:293. 1887.

Sida stellata Torrey, Ann. Lyc. N. Y., 2:171. 1928. Not *Sida stellata* Cav.

Sphaeralcea stellata Torrey and Gray, Fl. N. Am., 1:228. 1838.

Malva stellata Dietr., Syn. Pl., 4:816. 1847.

Sphaeralcea cuspidata Britton, *in* Britton and Brown, Ill. Fl., 3:519. 1898.

Differs from typical *S. angustifolia* as follows: plant usually more densely canescent; leaf blades often thicker, with veins more prominent beneath and the margins often revolute, usually narrower (linear-lanceolate), $1/10$–$1/3$ (usually about $1/5$) as wide as long, the basal teeth often more pronounced but not more than $1/10$ as long as the mid-lobe; flowers usually smaller, with petals 7–12 mm. long; calyx lobes more frequently deltoid-ovate and merely acute; petals usually grenadine or grenadine-pink, seldom drying lavender or violet; carpels (pl. 11, *D*) often less connate at maturity, usually very shallowly notched, the dehiscent portion usually narrower and more often acutish, with the ventral beak usually less prominent, usually mucronate or cuspidate, the indehiscent portion more distinctly and often somewhat prominently reticulate.

Type locality (of *Sida stellata* Torr.).—"Sources of the Arkansas." Type (Y) collected by Edwin P. James in 1820.

Geographical distribution and habitat.—Western Kansas and Colorado to western Texas and eastern Arizona, southward in Mexico to San Luis Potosí and Zacatecas, at elevations of 3000–7000 feet; also in southern California, where doubtless adventive. Habitat of the typical form.

Specimens examined (selected).—Kansas. Hamilton County: *Hitchcock* 47 (G, M, N, Y).

Colorado. El Paso County: Manitou, *Clements* 23 (G, M, N, S, Y). Fremont County: Canyon City, *Brandegee* 446 (C, M), in 1877 (F). Pueblo County: Pueblo, *Baker* et al. 7 (C, F, G, M, N, P, Y). Huerfano County: *Parry* 25 (G, M). Las Animas County: Trinidad, *Beckwith* 104 (Y). (?) County: sources of the Arkansas, *James* in 1820, the type collection (G,Y).

Texas. Potter County: Amarillo, *Ball* 1271 (C, N). Howard County: Big Spring, *Letterman* 5517 (Y). Brown County: Brownwood, *E. J. Palmer* 11901 (C, M). Ward County: Barstow, *Tracy and Earle* 44 (F, M, N, Y). Culberson County: Van Horn, *Kearney and Harrison* 28 (N). El Paso County: El Paso, *Mulford* 246 (M, Y). Jeff Davis County: Davis Mountains, *Ferris and Duncan* 2719 (CA, M, S, Y). Val Verde County: Del Rio, *E. J. Palmer* 11072 (N). Brewster County: Chisos Mountains, *Ferris and Duncan* 2851 (S), *Young* 144 (M), in 1916 (G), *Mueller* 8087 (Y). Bexar County: San Antonio, *Heller* 1700 (C, G, M, N, Y). (?) County: Western Texas to El Paso, *Wright* 58 (C, G, N, Y).

New Mexico. Union County: Clayton, *Carleton* 388 (N). San Miguel County: Las Vegas, *Anect* 23 (F, G, M, Y). Lincoln County: Gray, *Earle* 154 (C, M, N, Y), *Skehan* 41 (C, F, G, M, N, P, Y). White Mountains, *Wooton* 387 (C, G, M, N, P, S, Y). Otero County: Alamogordo, *Earle* 418 (N, P, Y). Grant County: Mangas Springs, *Metcalfe* 658 (A, G, M, N, Y). Luna County: Florida Mountains, *Mulford* 1086a (M, Y).

Arizona. Navajo County: Hopi Country, *Millspaugh* 190 (F). Yavapai County: Fort Verde, *Macdougal* 640 (N). Pinal County: Florence, *Toumey* 76 (A, N, S). Cochise County: Benson, *Jones* 24925 (C, CA, G, M, Y). Huachuca Mountains, *Lemmon* 3009 (C). San Simon, *Kearney and Harrison* 34 (N). Pima County: Tucson, *Abrams* 12673, in part (S), *Beard* in 1911 (M), *Pringle* in 1881 (F, M), *Toumey* in 1896 (N).

CALIFORNIA. Riverside County: Indio, *Parish* 8319, in part (G). Los Angeles County: Santa Monica, *Blake* 722 (N).

COAHUILA. Saltillo, *Palmer* 49 (C, G, M, N, Y), *Gregg* 234 (G, M).

CHIHUAHUA. Chihuahua, *Palmer* 48 (B, M, N, Y), *Pringle* 1065 (N, Y). Sapio, Sierra Madre, *Jones* in 1903 (P).

SONORA. Fronteras, *Thurber* 363 (G, Y).

DURANGO. Durango, *Palmer* 197 (B, C, G, M, N, Y).

SAN LUIS POTOSÍ. San Luis Potosí (?), *Parry and Palmer* 84 (G, M, N).

ZACATECAS. Cedros, *Kirkwood* 113 (M).

This subspecies, in the greater part of its range in the United States, usually is readily distinguishable from the typical form of the species, but numerous specimens from Texas and Mexico show complete intergradation. There is, apparently, almost perfect freedom of recombination of the characters, except that, among Mexican specimens, those with grenadine petals tend to have narrower leaf blades. The intergradation extends to all the diagnostic characters of *cuspidata* given by Gray (1887, p. 293), smaller leaves and flowers, red petals, and narrower, mucronate or cuspidate, more distinctly reticulate carpels. Only on the basis of averages may a distinction be drawn between the usually narrow-leafed, small-flowered plant with grenadine-colored petals and usually cuspidate, often pointed carpels, that occurs chiefly in the United States; and the relatively broad-leafed, large-flowered plant with mauve or lavender petals and very obtuse, muticous carpels, that predominates in Mexico. The character from which Gray took his varietal name is particularly unreliable, broad-leafed, "purple"-flowered specimens with cuspidate carpels being of frequent occurrence in Mexico; and narrow-leafed, "red"-flowered specimens with muticous carpels being often met with in the United States. Moreover, as in several other species, variation from muticous to cuspidate is not infrequent among the carpels of a single fruit.

Specimens that are atypical in being densely whitish canescent or almost tomentose and in having coarsely dentate leaf blades were collected in the Chisos Mountains in western Texas (*Ferris and Duncan* 2851) and in the Sierra Madre Mountains in Chihuahua (*Jones* in 1903). Other specimens collected in the Chisos Mountains (*Mueller* 8087, *Young* 144) are still more remarkable, being white-tomentose on the margins of the leaf blades, which are unusually short in Mueller's specimen and exceptionally rugose in Young's. Specimens from Manitou, Colorado (*Clements* 23), are unusual in having the bases of the leaf blades rounded, almost subcordate, instead of cuneate. A specimen from Chihuahua (*Pringle,* 1065) has leaf blades only 3.5 mm. wide. Collections in the vicinity of Tucson, Arizona, by Abrams, Beard, Pringle, and Toumey, have the leaf blades broader and more distinctly lobed than ordinarily in this form. They represent an approach to subspecies *lobata.* A plant found at San Simon, Arizona (*Kearney and Harrison* 34), had an exceptionally open, long-branched inflorescence and deeply notched petals.

At Del Rio, Texas (*E. J. Palmer* 11072), and Van Horn, Texas (*Kearney and Harrison* 28), specimens with petals that dried violet, but otherwise good *angustifolia cuspidata*, were collected. At Van Horn, this form grew in close

proximity to *S. subhastata* Coulter; and in the same spot were a multitude of plants showing various combinations of the characters of *angustifolia* and *subhastata.* There could be little doubt that they were interspecies hybrids. Most of them seemed nearer to *subhastata* in their short flowering stems that often originated well below the surface of the soil, short and relatively broad leaf blades, and coarsely and prominently reticulate carpels. In petal color, they varied from very pale pink, through mauve, to jasper red, but none of the presumable hybrids showed the clear grenadine color of *subhastata.* Other specimens suggesting this interspecies hybrid have been collected at Barstow, Texas (*Tracy and Earle* 44, G), Alpine, Texas (*E. J. Palmer* 34418, Y), and Saltillo, Coahuila (*E. Palmer* in 1880, G).

17*b*. **Sphaeralcea angustifolia lobata** (Wooton) comb. nov.

S. incana ? oblongifolia Gray, Pl. Wright, 2:21. 1853.

S. lobata Wooton, Bull. Torrey Club, 25:306, 307. 1898.

S. fendleri lobata Cockerell, Entomologist, 33:217. 1900.

S. lobata perpallida Cockerell, Bull. Torrey Club, 27:88. 1900.

S. fendleri perpallida Cockerell, Bull. So. Calif. Acad. Sci., 1:108. 1902.

Differs from typical *S. angustifolia,* and from the subspecies *cuspidata,* in the broader and more distinctly, usually subhastately, lobed leaf blades, these being oblong-lanceolate to ovate-oblong and $\frac{1}{3}$–$\frac{1}{2}$ as wide as long, with the subbasal teeth or lobes $\frac{1}{10}$–$\frac{1}{5}$ as long as the mid-lobe (rarely longer), usually ascending and acutish but sometimes more divergent and obtuse; margins of leaf blades often more coarsely and irregularly dentate than in typical *angustifolia,* the mid-lobe sometimes pinnately few-cleft; petioles of the lower leaves usually longer, frequently $\frac{1}{3}$ and sometimes nearly $\frac{1}{2}$ as long as the blade; seeds pubescent, often copiously so. In other characters, this form resembles subsp. *cuspidata,* but the leaf blades are usually flat and the carpels (pl. 11, *E*) are more often free at maturity and nearly always cuspidate, with cusps up to nearly 2 mm. long. The petals are usually grenadine but sometimes pink, drying lavender or violet.

Type locality (of *Sphaeralcea lobata*).—Mesilla, Dona Ana County, New Mexico, at an elevation of 3900 feet. Type (NM) collected by E. O. Wooton, July 14, 1897, No. 2.

Geographical distribution and habitat.—Western Texas, southern New Mexico, and northwestern Chihuahua, mostly at elevations of about 4000 feet. Habitat of *S. angustifolia* f. *typica.*

Specimens examined.—TEXAS. Reeves County: *Wolf* 1611 (N). Pecos, *Tracy and Earle* 121 (C, F, G, M, N). Hudspeth County: *Cory* 2035 (N), 2037 (N), 2038 (N). El Paso County: Canutillo, *Barlow* in 1911 (CA, F, N). El Paso, *Jones* 3778 (A, C, F, N, P, S, Y), *Letterman* in 1880 (M), *Rose* 1189 (F, G, N, Y). San Elizario, *Wright* 1329[37] (G, N). Ysleta, *Ferris and Duncan* 2445 (CA, S). Jeff Davis County: Fort Davis, *Eggleston* 17383 (M). Limpia Mountains, *Bigelow* (Y). Brewster County: Alpine, *Harrison and Kearney* 3 (N), *E. J. Palmer* 34418 (M). Brewster (or Presidio) County: Tierra Vieja Mountains, *Havard* 7 (G, N).

NEW MEXICO. Torrance County: Willard, *Kearney and Leding* 27 (F, N). Eddy (or Otero) County: Guadalupe Mountains, *Standley* 40627 (N). Otero County: Tularosa Creek, *Wooton* in 1897 (N). Dona Ana County: Las

[37] Type collection of *S. incana (?) oblongifolia* A. Gray.

Cruces, *Kearney and Leding* 1 (N), 2 (N). Mesilla, *Dewey* in 1891 (N), *Fosberg*, S3292 (C, P), *Tinsley* in 1896 (N), *Wooton* 2, the type collection (C, G, M, N, NM), 15 (M, N, S), in 1899 (N). Mesilla Valley, *Ferris* 1156 (S), *Standley* 6389 (N), in 1906 (M, N). Rincon, *Cockerell*[38] (N). Sierra County. Hopkins Mill, *Wooton* 2663 (N, P), 2665 (N). Hidalgo County: Crawfords Ranch, *Wooton* in 1906 (N).

CHIHUAHUA.—Corralitos to El Paso, *Thurber* 738 (G, Y).

This subspecies intergrades with *angustifolia cuspidata,* on the one hand, and with *fendleri elongata,* on the other. The relationship to the latter was considered in the discussion of that subspecies, the intergradation with which seems to be completed by two New Mexican specimens cited under *angustifolia lobata,* one from the Guadalupe Mountains (*Standley* 40627) with rather coarsely serrate leaf blades, and one from Tularosa Creek (*Wooton* in 1897). A peculiar form collected at Alpine, Texas (*Kearney and Harrison* 3), resembles *fendleri elongata* in its sparse pubescence and thin leaf blades, but is unlike that form in its short and relatively broad blades. A number of collections in Texas and one in Chihuahua (*Thurber* 738), otherwise typical of subsp. *lobata,* have petals that dried lavender or violet. Very aberrant specimens, in which the leaf blade is deeply cleft and narrowly lobed, with the mid-lobe pinnately toothed or cleft, have been collected in Dona Ana and Hidalgo counties, New Mexico, by Wooton and others.

There is a rather striking resemblance between *angustifolia lobata* and some specimens of *emoryi variabilis,* but in the latter form the leaves are usually more or less cordate rather than cuneate at base, are obtuse rather than acute or acuminate at apex and have broader, more rounded lobes. Also, in this form of *emoryi* the carpels usually are more coarsely and prominently reticulate and more pronouncedly tuberculate dorsally than in any form of *angustifolia,* and the attaching threads are much shorter and more fragile. *S. emoryi* is a more western species and the ranges of the two forms scarcely overlap.

18. **Sphaeralcea hastulata** Gray, Pl. Wright., 1:17, 18. 1852.

Plant perennial, with a slender or rather stout, subligneous root, the stems originating from a small crown or often farther below the surface of the soil, apparently as root shoots. Stems few or several, usually decumbent, up to 30 cm. long but usually shorter, commonly less than 2 mm. in diameter at base, usually sparsely and substrigosely pubescent but sometimes rather densely canescent, the hairs rather stiff and thick-walled, 4–7 mm. long, with 7–13 rays. Leaf blades thin, with veins not very prominent beneath, usually bright green and rather sparsely pubescent above, paler and densely sericeous-pubescent beneath with stiffer, thicker-walled hairs on the veins, oblong-ovate or ovate-lanceolate, at base subcuneate to strongly cuneate (sometimes truncate or even subcordate), at apex acute or short-acuminate, 3- (sometimes 5-) veined from the base, usually merely subhastately toothed or shallowly lobed with rounded teeth or lobes less than ⅕ as long as the mid-lobe (sometimes deeply cleft with much longer lateral lobes), margin nearly entire to coarsely and irregularly crenate-dentate or the mid-lobe even pinnately cleft, the larger

[38] Type collection of *S. lobata perpallida* Cockerell and *S. fendleri perpallida* Cockerell.

blades 2–6 cm. long and 1/3–3/5 as wide. Petioles slender, those of the lower leaves about 1/2 as long as the blade. Inflorescence racemiform, with usually only one flower at each node and seldom more than 8 per stem. Pedicels slender, the lower ones often much longer than the calyx. Calyx at anthesis 6–11 mm. high, with lanceolate or ovate-lanceolate, acuminate lobes 1–2 times as long as the tube. Petals grenadine, 15–20 mm. long. Column sparsely pubescent. Styles pink, stigmas dark red. Fruit higher than hemispherical, broader than high, about 2/3 as high as the calyx, usually promptly deciduous at maturity. Carpels (pl. 11, *F*) 14–20, thickish, with chartaceous walls, 3–5 mm. high, about 3/4 as wide, narrowly and very deeply notched, often slightly constricted dorsally opposite the notch, the dehiscent portion erect, deltoid, with a very prominent ventral beak, obtuse or acute at apex, usually muticous but sometimes mucronate or cuspidate, sometimes sparsely spinulose dorsally toward apex, the indehiscent portion forming 3/5–3/4 of the carpel, usually conspicuously wider than the dehiscent portion, coarsely and very prominently reticulate, often nigrescent, conspicuously muricate dorsally; attaching threads short, apparently often wanting. Ovules usually 2. Seeds 1 or 2, sparsely pubescent or glabrous.

Type locality.—"Prairies beyond the Pecos," Texas.[39] Type (G) collected by C. Wright in 1849, No. 43.

Geographical distribution and habitat.—Central and southern Texas, chiefly east of meridian 106°, and southward to San Luis Potosí, Mexico, at elevations of 1000–4000 feet. Grows on plains, in hard, more or less gravelly, or sometimes sandy, soil.

Specimens examined.—TEXAS. Brown County: *Reverchon* 1251 (F), 1252 (M, N, Y). Tom Green County: *Nealley* 82 (S). Irion County: *Cory* 548 (G), 549 (F, N), 551 (N). Ward County: Barstow, *Earle* 610 (Y). Sutton County: Sonora, *Moldenke* 7009 (Y). Crockett County: *Cory* 547 (N). Crockett (or Pecos) County: Ozona to Fort Stockton, *Hanson* 28 (N). Pecos County: Fort Stockton, *Kearney and Harrison* 12, etc. (N), *Wooton* in 1913 (N), *York* 264 (S). Reeves (or Pecos) County: Balmorhea to Fort Stockton, *Schulz* 2113 (P). Val Verde County: *Cory* 546 (N), *Jones* in 1930 (P). Comstock, *E. J. Palmer* 12965 (M). Del Rio, *E. J. Palmer* 11362 (M). Brewster County: Marathon, *Ferris and Duncan* 2749 (CA, M, S, Y). Presidio County: Marfa, *Plank* (Y). Kinney County: Fort Clark, *Mearns* 1387 (N). Spofford, *Canby* et al. 47 (N). Frio(?) County: Rio Frio, *Berlandier* 173 (G). Maverick County: Eagle Pass, *Havard* 5 (G). Quemado, *Kearney and Harrison* 8 (N). Duval County: San Diego, *Croft* 105 (N, Y). Starr County: Roma, *Hanson* 28[40] (N). Jim Hogg County: Hebronville, *Hanson* in 1919 (G, M, Y). (?) County: Clear Fork of Brazos, *Hayes* 76 (G). Guadalupe, *Palmer* in 1880 (M). Howard Springs Valley, *Schott* 851 (Y). Prairies beyond the Pecos, *Wright* 43, the type collection (G). Rio Pecos, *Thurber* 117 (S). Locality ? *Wright* 883, in part (G, M, N, Y).

COAHUILA. Saltillo, *Arsène* et al. 6463 (N).

DURANGO. Mapimí, *Palmer* 541 (C, M, N, Y), 556 (C, M, N, Y).

SAN LUIS POTOSÍ. La Meroma, *Seler* 3504 (G). San Miguelito Mountains and valley of San Luis Potosí, *Schaffner* 165 (G, Y).

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39 Gray (1853, p. 21) gives "sandy valleys of the Mimbres Mountains" as an additional locality, but there are specimens of both *hastulata* and *S. subhastata* Coulter under the number cited (*Wright* 883). It was doubtless *subhastata* that Wright collected in the Mimbres, New Mexico, region.

40 Another sheet bearing the same number is labeled as from "Ozona to Fort Stockton."

This species has often been confused with *S. subhastata* Coulter, the only other North American species to which it has any marked resemblance. The ranges of the two species barely overlap in Texas, the distribution of *hastulata* being chiefly more eastward and at lower elevations than that of *subhastata.* Most specimens of *hastulata* may be distinguished readily from *subhastata* by their thinner leaf blades, contrasting color and pubescence of the two surfaces of the blade, and muticous carpels, with the indehiscent (reticulate) portion considerably wider than the dehiscent portion.

Specimens from Texas with deeply cleft or almost parted leaves, but not otherwise different from the typical form are: *Reverchon* 1251 and 1252, Brown County; *Hayes* 76, Clear Fork of the Brazos; *Thurber* 117, Rio Pecos. Approaching this form, but with less deeply incised leaves are: *Canby* et al. 47, Spofford, Texas, and specimens collected by Hanson at Roma and Hebronville, Texas. A remarkably small-flowered form, with petals only about 4 mm. long, was collected near Fort Stockton, Texas (*Kearney and Harrison* 16). Other collections in the same vicinity (*Kearney and Harrison* 13, 15) are roughly pubescent with unusually long hairs (0.7 mm. long) and have the reticulate portion of the (otherwise typical) carpels not wider than the unreticulate portion. Still another collection near Fort Stockton (*Kearney and Harrison* 17) is very atypical in having the carpels cuspidate with slender cusps more than 1 mm. long, but in all other characters the plant seems typical *hastulata.*

In Mexico, this species occurs in a number of forms, some of which are referred doubtfully to *hastulata.* Specimens from the state of San Luis Potosí (*Schaffner* 165, *Seler* 3504) with unusually small, narrow leaves and the reticulate portion of the carpel not appreciably wider than the dehiscent portion, seem to connect with *subhastata.* Schaffner's specimen also approaches *subhastata* in having short-cuspidate carpels. At Mapimí, Durango, Palmer collected specimens of typical *hastulata* (No. 556) and specimens (No. 541) that resemble *subhastata* in some of their characters, but that are far from typical of either species. These are whitish canescent, with little differentiation in the pubescence of the two surfaces of the rather thick and rugose-veined leaf blades, and the stems are woodier at base than is usual in *hastulata.* The carpels, however, are typical of *hastulata,* although exceptionally small. Another striking variant, collected at Saltillo, Coahuila (*Arsène* et al. 6463) is glabrescent and has exceptionally large leaf blades, 6 cm. long, that are strongly cuneate at base. A specimen from Irion County, Texas (*Cory* 551), somewhat resembles this form but is less aberrant.[41]

[41] An extraordinary form, collected on the Cerro de San Ignacio, Durango (*Purpus* 4618, C), seems to be intermediate between *hastulata* and *S. ambigua* Gray, although collected far southeast of the known range of *ambigua.* In the shape, thickness, prominent veins, and pubescence of the leaves, the resemblance is closer to *ambigua* than to *hastulata.* The carpels are like those of *hastulata,* except that the indehiscent portion is not wider than the dehiscent portion. The collection consists of a single, incomplete specimen in an advanced stage of maturity. Additional material is required to establish the status of this form, which may prove to be an undescribed species.

19. **Sphaeralcea subhastata** Coulter, Contr. U. S. Nat. Herb., 1:32, 33. 1890.

S. simulans Woot. and Standl., Bull. Torrey Club, 36:109. 1909.

S. arenaria Woot. and Standl., Contr. U. S. Nat. Herb., 16:147. 1913. Not Phillipi, 1892.

Plant perennial, with a slender or fairly stout taproot, with or without a distinct crown (if without crown the stems originate considerably below the surface of the soil, apparently as root shoots), canescent, often densely so, with usually rather stiff hairs, those of the stem 0.3–0.5 (rarely only 0.15) mm. long, with 10–20 rays. Stems decumbent, ascending or nearly erect, up to 50 cm. long but usually much shorter, seldom more than 2 mm. in diameter at base. Leaf blades usually thickish with veins prominent beneath, flat or somewhat rugose, usually much more sparsely pubescent on the upper than on the lower surface, oblong-lanceolate to narrowly ovate, at base cuneate, usually strongly so, at apex acute or short acuminate, 3-veined from the base, scarcely lobed but usually subhastately angled or toothed at base with ascending teeth, margin nearly entire to irregularly crenate or dentate, the larger blades 2–5.5 cm. long and ¼–½ as wide. Petioles usually slender, commonly less than half as long as the blade. Inflorescence few-flowered (flowers seldom more than 12 and often much fewer), racemiform or with 2 flowers at some of the lower nodes, usually leafy nearly to the apex. Pedicels usually stout and shorter (often much shorter) than the calyx. Calyx at anthesis 4–11 mm. high, with usually lanceolate or ovate-lanceolate, attenuate-acuminate lobes 1–2½ times as long as the tube. Petals grenadine (rarely pink or drying violet), 10–18 mm. long. Column sparsely pubescent or glabrescent. Fruit truncate-conical, usually considerably lower than the calyx, promptly deciduous at maturity. Carpels (pl. 11, G) 10–17, thickish, with chartaceous walls, seldom connate at maturity, 4–6 mm. high and about ½ as wide, rather narrowly and deeply notched, usually slightly constricted dorsally opposite the notch, the dehiscent portion erect, ovate or deltoid-ovate with a prominent ventral beak, usually acute or acutish, usually cuspidate with cusps up to nearly 2 mm. long (rarely muticous), occasionally sparsely spinulose dorsally toward the apex, the indehiscent portion forming ⅓–½ of the carpel, coarsely and very prominently reticulate, often nigrescent, rugose-tuberculate or muricate dorsally; attaching threads long or short, often apparently wanting. Ovules 2 (rarely 1). Seeds usually 2, glabrous to copiously pubescent.

Type locality.—Screwbean, Presidio County, Texas. Type (N) collected by G. C. Nealley in 1889, No. 56.

Geographical distribution and habitat.—Western Texas, chiefly west of meridian 106°, to southeastern Arizona, Coahuila, Chihuahua, and Durango, at elevations of 3000–5000 feet. Inhabits treeless plains and mesas, usually in relatively impermeable soils of fine texture and often of red color. Sometimes occurs in moderately saline soil, growing with *Sporobolus airoides*, etc.

Specimens examined.—TEXAS. Sterling County: *Tharp* 3587 (N). Pecos County: 20 miles west Fort Stockton, *Kearney and Harrison* 18 (N). Reeves County: Pecos, *Hanson* 44A (N). Culberson County: *Cory* 2024 (F, N), 15 miles east Van Horn, *Kearney and Harrison* 26 (N), 27 (N). Hudspeth County: *Cory* 2016 (N). Sierra Blanca, *Eggert* in 1900 (M), *Hanson* 28E (G, N), *Mearns* 1524 (N), *Orcutt* 6174 (M). El Paso County: El Paso, *Whitehouse* 8406 (F). Fort Bliss, *Ferris and Duncan* 2367 (CA, S, Y). Presidio County: Marfa, *Leding* in 1933 (N), *Kearney and Harrison* 1 (N). Marfa to Rancheria, *Havard* 5 (G, N). Screwbean, *Nealley* 56, the type collection (N). (?) County: Rio Pecos, *Thurber* 117 (G, Y). Locality ?, *Wright* 887 in part (M).

NEW MEXICO. San Miguel County: Las Vegas, *Anect* 24 (Y). Chaves County: Roswell, *Wooton* in 1914 (N). Chaves (or Eddy) County: Roswell to Carlsbad, *Nelson* 11349 (C, R). Lincoln County: Carrizozo, *Kearney and Leding* 31 (F, N). Oscuro, *Kearney and Leding* 32 (F, N, Y). Socorro County: *Eggleston* 19436 (N). Socorro, *Rusby* 48 (F, M in part). Otero County: Chosa Spring, *Wooton* in 1905 (C, N). White Sands, *Wooton* 165[42] (G, M, N, R, S, Y), 2662 (N). Sierra (or Grant) County: Mimbres Mountains, *Wright* 883, in part[43] (G, N). Grant County: Fierro, *Holzinger* in 1911 (M). Dona Ana County: near Organ Mountains, *Wooton* in 1899 (N). Luna County: Deming, *Wooton* in 1906[44] (N). Providencia Lake, *Kearney and Leding* 5 (N, Y), *Wooton* in 1900 (N).

ARIZONA. Cochise County: Cochise, *Griffiths* 1917 (Y). Cochise to Dragoon, *Harrison and Kearney* 43a (N). San Simon Valley, *Goodding* 1289 (Y), *Toumey* 6 (G, N), 16 (G). Bowie, *Eastwood* 8609 (CA, G).

COAHUILA. Saltillo, *Fisher* 219 (N), in 1926 (S), *Gregg* 92 (M), *Palmer* 93 (G, N), 1009 (N).

CHIHUAHUA. Candelaria, *Stearns* 303 (N). Casas Grandes, *E. W. Nelson* 6332 (N). Sabinal, *Jones* in 1903 (P).

DURANGO. Mapimí, *Palmer* 555 (N).

S. subhastata is a highly variable species, even if the forms here treated as subspecies are left out of account. *S. arenaria* Woot. and Standl. is a relatively tall form with ascending or nearly erect, often numerous stems and with leaf blades usually only angulate or obscurely toothed at base. It intergrades completely with the typical form. A collection (*Wooton* 2662) at White Sands, New Mexico, the type locality of *S. arenaria* Woot. and Standl., comprises one specimen with typical *subhastata* carpels and two specimens that are superficially similar but have smaller carpels with the indehiscent portion considerably wider than the dehiscent portion, a character of *hastulata*. Specimens with pale pink petals, that did not change color in drying, were collected in Culberson County, Texas (*Kearney and Harrison* 27). A specimen with petals that dried lavender was collected in Chihuahua (*Stearns* 303). The type of *S. simulans* Woot. and Standl., collected at Deming, New Mexico, and Rusby's collection at Socorro, New Mexico, have rather deeply cleft leaf blades and are, in that respect, intermediate between typical *subhastata* and subsp. *pumila*. A specimen collected between Roswell and Carlsbad, New Mexico (*Nelson* 11349), resembles subsp. *martii* in its long, relatively many-flowered inflorescence, but is like the typical form in pubescence and leaf shape.

As in *hastulata*, peculiar forms have been collected in Mexico. A plant from Casas Grandes, Chihuahua (*E. W. Nelson* 6332), has exceptionally long, narrow leaves, about 4 times as long as wide, and rather short and relatively broad carpels, much like those of subsp. *pumila*. A very aberrant form was collected at Mapimí, Durango (*Palmer* 555). The plant is whitish canescent, has a thick, woody root, a well-developed crown, and large flowers, with the calyx 14 mm. high and petals 20 mm. long. It resembles *hastulata* in having semi-

[42] Type collection of *S. arenaria* Wooton and Standley.

[43] See note 40 *supra*.

[44] Type collection of *S. simulans* Woot. and Standl.

sericeous pubescence on the lower leaf-surface, but the carpels, although exceptionally large (6.5 mm. high), are of typical *subhastata* shape. In habit and appearance, this plant resembles another collection at the same locality (*Palmer* 541) that was referred to *hastulata* on the characters of the carpels.

19*a*. **Sphaeralcea subhastata connata** subsp. nov.

A forma typica *S. subhastatae,* laminis foliorum plerumque latioribus saepius prope basim distincte incisis, carpidiis maturis plerumque solide connatis parte indehiscente saepe parviori et plus subtiliter reticulata, distinguitur.

Differs from typical *subhastata* also as follows: hairs usually shorter, softer and thinner-walled, often with more numerous rays, those of the stem 0.20–0.25 mm. long, with 12–25 rays; leaf blades about ½ as wide as long; carpels seldom separable without tearing; seeds often copiously pubescent.

Type locality.—Between Rio Puerco and Suwanee, Valencia County, New Mexico. Type (N) collected by T. H. Kearney and A. R. Leding, October 1, 1932, No. 20.

Geographical distribution and habitat.—Northwestern New Mexico to northeastern and central Arizona at elevations of 5000–7000 feet. Inhabits treeless plains and mesas, in sandy or gravelly soil.

Specimens examined.—New Mexico. Bernalillo County: Albuquerque, *Harward* (M), *Herrick* in 1894 (N, Y). Valencia County: Rio Puerco to Suwanee, *Kearney and Leding* 20, the type collection (N, Y), 23 (N, Y). Suwanee, *Wooton* in 1906 (N).

Arizona. Navajo County: Bidahuchi, *Hough* in 1901 (N). Holbrook, *Hough* 25 (N), in 1897 (N), *Zuck* in 1896 (C, F, M, N), in 1897 (C, M, N). Hopi Reservation, *Hough* 15 (N). St. Joseph, *Wooton* in 1892 (N, Y). Winslow, *Griffiths* 5007 (N), *Jones* in 1884 (P). Coconino County: Bill Williams Mountain, *Rusby* (Y). Grand Canyon, *Toumey* 83A (N). Moencopie Wash, *Jones* in 1890 (P). San Francisco Mountains, *Fulton* 7374 (N), *Knowlton* 209 (N), *Leiberg* 5917 (N). Tanners Crossing, *Ward* in 1901 (N). Williams, *Shreve* 4844 (N). Yavapai County: near Prescott, *Peebles, Harrison, and Kearney* 8828, etc. (N). Dewey, *Peebles, Harrison, and Kearney* 8894 (N), 8895 (N).

This subspecies, usually easily distinguished from the typical form of *subhastata* in having the carpels strongly connate and separating from the axis in a complete ring, is also distinct geographically, occurring farther to the northwest than any other form of *subhastata.* In habit, it often resembles the form described by Wooton and Standley as *S. arenaria,* the stems being usually numerous, rather long and ascending or nearly erect, but differs from *arenaria* in its more incised leaves and connate carpels. Two of the specimens referred by the writer to subsp. *connata* (*Herrick* in 1894, Albuquerque, New Mexico, and *Wooton* in 1906, Suwanee, New Mexico) were cited in the original description of *S. arenaria* Woot. and Standl.

The inflorescence is usually racemiform, as in typical *subhastata,* but an exceptionally large specimen from the San Francisco Mountains, Arizona (*Fulton* 7374), has a subthyrsoid inflorescence with numerous flowers. In this respect, it resembles subsp. *thyrsoidea,* of southern Arizona, but the leaves are less incised. Specimens that have the carpels separating freely at maturity but that are like subsp. *connata* in other characters, were collected in Yavapai

County, Arizona (*Peebles, Harrison, and Kearney* 8828, 8829, 8832, 8895). Specimens from Yavapai County that are more or less intermediate between this subspecies and subsp. *pumila* are mentioned under the latter. A form collected by Hough near Holbrook in 1897 is exceptionally delicate, with numerous, very slender, much-branched stems, small, thin, rather deeply cleft leaves, and rather small carpels that separate freely at maturity. A somewhat similar form, but with connate carpels, was collected in the San Francisco Mountains (*Leiberg* 5917). Collections at Albuquerque, New Mexico (*Herrick* in 1894), and at Winslow, Arizona (*Griffiths* 5007), that seem otherwise to be good *connata,* have relatively short and broad carpels, approaching subsp. *pumila* in this character.

19*b*. **Sphaeralcea subhastata martii** (Cockerell) comb. nov.

S. martii Cockerell, Bot. Gaz., 32:60. 1901.

Differs from the typical form of *S. subhastata* as follows: plant conspicuously and densely whitish canescent or subtomentose; stems comparatively stout, usually about 2.5 mm. in diameter at base; leaf blades broader, ovate-lanceolate or ovate, ½–⅔ as wide as long, subhastately cleft with lobes or teeth ⅙–¼ as long as the mid-lobe; petioles relatively longer, often nearly equaling the blade; inflorescence more often subthyrsoid, with 2 or 3 flowers at some of the lower nodes, less leafy, all but the lowest leaves being reduced to minute bracts; pedicels more slender and longer, frequently equaling or somewhat longer than the calyx; flowers usually larger, the petals 15–20 mm. long; carpels (pl. 11, *H*) strongly connate at maturity, often somewhat broader than in the typical form.

Type locality.—Picacho Mountain, Dona Ana County, New Mexico. Type (NM) collected by T. D. A. Cockerell, March 25, 1900.

Geographical distribution and habitat.—Western Texas and central and southern New Mexico, at an elevation of about 3500 feet. Inhabits well-drained, stony hillsides and the banks of arroyos.

Specimens examined.—TEXAS. El Paso County: El Paso, *Hanson* 28B (G), in 1919 (M, Y). Presidio County: Shafter, *Hanson* 28C.

NEW MEXICO. Bernalillo County: Albuquerque, *Casteller* 1226 (R), *Kammerer* 8 (F, M, N, Y). Dona Ana County: Jornada Range Reserve, *Chaplin* in 1915 (N). Picacho Mountain, *Cockerell* in 1900, the type collection (N, NM). Shalam Hills, *Kearney and Leding* 36 (N, Y), *Leding* in 1933 (N, Y), *Wooton* in 1900 (N, NM). Eddy (?) County: Globe Springs, *Whitehouse* 8400 (F).

This form resembles subsp. *connata* in having the carpels strongly connate and separating from the axis in a complete ring, but differs from *connata* in its conspicuous, whitish pubescence. The plant, as seen by the writer in the dry, rocky Shalam Hills, very near the type locality, has a different habitat from that ordinarily preferred by *connata* and the other forms of *subhastata;* but a specimen collected by Hanson at Shafter, Texas, is labeled as occurring "in valleys." In the specimens from Picacho Mountain and the Shalam Hills, New Mexico, the pubescence is denser, softer, and whiter, and the hairs, especially on the backs of the carpels, are longer than in other forms of *subhastata*. None of the other specimens here referred to subsp. *martii* are so extreme in the character of their pubescence.

19*c*. **Sphaeralcea subhastata latifolia** subsp. nov.

A forma typica *S. subhastatae,* laminis foliorum latioribus ovatis obtusis distincte sed non profunde lobatis lobis et dentibus obtusissimis, inflorescentia supra saepe subnuda floribus pluribus, distinguitur.

Differs from the typical form of *subhastata* also as follows: stems often taller and stouter, up to 35 cm. long and more than 3 mm. in diameter at base; leaf blades more than ½ and often ⅔ as wide as long.

Type locality.—Barstow, Ward County, Texas. Type (N) collected by S. M. Tracy and F. M. Earle, April 14, 1902, No. 24.

Geographical distribution and habitat.—Western Texas, southeastern New Mexico, and northern Chihuahua, at elevations of 3000–6500 feet. Inhabits treeless plains and slopes.

Specimens examined.—TEXAS. Ward County: Barstow, *Tracy and Earle* 24, the type collection (F, G, M, N, Y), 58 (Y), 59 (Y), 108 (Y). Culberson County: *Cory* 2044 (M, N). Kent, *Kearney and Harrison* 21 (N), 23 (N), *Jones* 2633 (M, P). Hudspeth County: *Cory* 2050 (N). Sierra Blanca, *Eggert* in 1901 (M). Fort Bliss, *Carlson* in 1915 (CA). Pecos County: 20 miles west Fort Stockton, *Kearney and Harrison* 18 (N). Presidio County: Marfa, *Eggert* in 1901 (M), *Ingram* 2462 (N).

NEW MEXICO. Eddy County: mouth of Delaware Creek, *Pope* in 1855 (C, G).

CHIHUAHUA. Madera, *Palmer* 265 (N).

Some of the specimens with narrower and less incised leaf blades (*Jones* 2633, *Tracy and Earle* 24, in part), connect this subspecies with typical *subhastata*. A collection at Kent, Texas (*Kearney and Harrison* 21), had pink petals that dried violet. It is aberrant, also, in the *pumila*-like, small, and relatively shallowly cleft calyx, but is typical *latifolia* in foliage. Several other specimens from this vicinity have relatively short and broad carpels, with the indehiscent portion somewhat wider than the dehiscent portion, approaching subsp. *pumila* in these characters; but the calyx is usually large, with narrow, attenuate-acuminate lobes, as in *subhastata* f. *typica.*

Collections at Marfa, Texas (*Kearney and Harrison* 1, *Leding* in 1933), listed under *subhastata* f. *typica,* approach subsp. *latifolia* in their rather broad and distinctly cleft leaf blades, but these have narrower and more pointed lobes and teeth, and the few-flowered inflorescence is racemiform. Somewhat similar specimens, also listed under *typica,* were collected at Fort Bliss, Texas (*Ferris and Duncan* 2367), and in Socorro County, New Mexico (*Eggleston* 19436, *Rusby* 48).

19*d*. **Sphaeralcea subhastata thyrsoidea** subsp. nov.

A forma typica *S. subhastatae,* laminis foliorum latioribus oblongo-ovatis vel late ovatis plerumque 5-nervatis et profunde incisis vel partitis, inflorescentia omni subthyrsoidea supra subnuda floribus pluribus (saepe 20–30) 2–3 per nodum, pedicellis plerumque tenuoribus calyci saepe aequilongis vel longioribus, distinguitur.

Differs from the typical form of *subhastata* also as follows: stems usually taller, up to 45 cm. long, and stouter, up to 3 mm. in diameter at base; hairs shorter, thinner-walled, and with more numerous rays, those of the stem 0.15–0.25 mm. long, with 18–25 rays; leaf blades usually more than ½ as wide as long, at base often truncate or even subcordate, 3-cleft to almost 3-divided

with the lateral divisions often deeply cleft, these 1/4–3/5 as long as the mid-lobe and sometimes broad and rounded, sometimes narrow and wedge-shaped, the mid-lobe usually deeply and irregularly pinnately toothed or cleft but sometimes shallowly and more regularly crenate; inflorescence leafy only toward base, appearing naked most of its length.

Type locality.—Ten miles west of Tucson, Pima County, Arizona. Type (N) collected by George J. Harrison, April 26, 1930, No. 6825.

Geographical distribution and habitat.—Southern Arizona, at elevations of 2000–3000 feet. Inhabits treeless plains, often growing in depressions that are occasionally covered with water, preferring relatively impermeable soils of fine texture.

Specimens examined.—ARIZONA. Pima County: Baboquivari Valley, *Griffiths* 3966 (N). Tucson, *Griffiths* 2555 (G, Y), 3523 (N), *Harrison* 6818 (N), 6824 (F, N), 6825, the type collection (N), 6826 (N), *Harrison and Kearney* 8524 (CA, N), 8525 (N, Y), 8526 (N), *Mrs. Thornber* 4001 (A). Tucson to Rincon Mountains, *Eastwood* 17806 (CA). Wilmot, *Thornber* 4110 (A), 4882 (A), 4883 (A), 4887 (A), 5330 (A).

This subspecies, in its extreme form, seems very distinct in its vegetative characters from typical *subhastata,* but it is exceedingly variable and there is overlapping in all characters. The fruit is in every respect typical. The narrow, long-acuminate calyx lobes, large flowers with petals 13–18 mm. long, and relatively narrow carpels distinguish this form from subsp. *pumila,* which it resembles in its deeply incised leaves.

The leaves are relatively large for *subhastata,* with blades usually 4–6 cm. long. The fruit is often capped by the marcescent corolla, which appears to be more persistent than in other forms of *subhastata.* The carpels, 13–17 in number and 5–6 mm. high, either separate freely at maturity or are slightly connate in pairs, but are nearly always separable without tearing. In some of its characters, this form resembles subsp. *martii,* but *martii* is much more conspicuously whitish pubescent, has less deeply incised leaves, a less thyrsoid, fewer-flowered inflorescence, and strongly connate carpels. Just as *subhastata* is represented by subsp. *connata* in the extreme northwestern portion of its range and at the highest elevations it attains, it is represented by subsp. *thyrsoidea* in the extreme southwestern portion of its range and at the lowest altitude at which it occurs.

19*e*. **Sphaeralcea subhastata pumila** (Woot. and Standl.) comb. nov.

S. pumila Woot. and Standl., Bull. Torrey Club, 36:110. 1909.

? *S. glabrescens* Woot. and Standl., Bull. Torrey Club, 36:107. 1909.

Differs from the typical form of *S. subhastata* as follows: leaf blades ovate to nearly orbicular in outline, at base subcuneate to subcordate, at apex obtuse or acutish, often 5-veined from the base, deeply 3-cleft to almost 3-divided with the lateral divisions 1/3–3/5 as long as the mid-lobe and often deeply cleft, the mid-lobe usually pinnately toothed or cleft; flowers usually smaller; calyx lobes deltoid or ovate-lanceolate, acute or short-acuminate, usually not more than 1 1/2 times as long as the tube; petals 9–13 mm. long; fruit slightly lower to slightly higher than the calyx; carpels (pl. 11, *I*) often strongly connate at maturity, 3.5–5 mm. high, 3/5–3/4 as wide, often obtuse.

Type locality.—Diamond A Wells, Silver City Draw, Grant County, New Mexico. Type (NM) collected by E. O. Wooton, July 1, 1906.

Geographical distribution and habitat.—Southern New Mexico to central Arizona, at elevations of 4000–6000 feet. Inhabits treeless, usually grass-covered plains and mesas.

Specimens examined.—New Mexico. Lincoln County: White Mountains, *Wooton* in 1901 (N). Socorro County: *Eggleston* 19377 (N). Socorro, *Plank* in 1895 (Y), *Rusby* 48, in part (M). Sierra County: Hot Springs, *Mulford* 1143 (M). Lake Valley, *Beals* in 1914 (N). Grant County: Jackson, *Kearney and Leding* 7 (N, Y). Mangas Springs, *Metcalfe* 155 (C, G, M, N, P, S, Y), *Wooton* in 1900 (N), in 1902 (N). Near Silver City, *Wooton* in 1906, the type collection (N, NM). Dona Ana County: Jornada Range Reserve, *Wooton* in 1913 (N). Luna County: Providencia Lake, *Wooton* in 1900[45] (N, NM, Y). Hidalgo County: Stein Pass, *Toumey* in 1895 (N).

Arizona. Navajo County: Holbrook, *Zuck* (Y), in 1896 (F). Coconino County: Tuba City, *Clute* 112 (G, M, N, Y), *Harrison* 8708 (F, N). Yavapai County: Ashfork, *Toumey* 15 (G). Camp Verde to Prescott, *Fernow* in 1896 (N). Dewey, *Peebles, Harrison, and Kearney* 8897 (N). Kirkland, *Peebles, Harrison, and Kearney* 8831 (N), 8835 (N), 8836 (N). Prescott, *Peebles, Harrison, and Kearney* 8850 (N), 8853 (N). Cochise County: near Rodeo, New Mexico, *Peebles and Loomis* 5381 N). San Simon to Bowie, *Harrison and Kearney* 35 (N). Willcox, *Harrison and Kearney* 46 (N).

This form resembles subsp. *thyrsoidea* in its deeply dissected leaves, but is nearer typical *subhastata* in its few-flowered, usually simple inflorescence. It differs from all other forms of the species in its smaller, less deeply cleft calyx with less attenuate lobes, and broader carpels, considerably more than ½ as wide as high. In its extreme expression, *pumila* seems to be very distinct from *subhastata,* and the writer was long inclined to maintain it as a species. Its geographical distribution is, however, comprised within that of the polymorphic *subhastata;* and specimens of intermediate character are far too numerous throughout the range of subsp. *pumila* to warrant maintenance of *pumila* as a species.

The decision as to whether a given specimen belongs to subsp. *pumila* is often difficult if it lacks mature fruit. The type collection of *S. glabrescens* Woot. and Standl. illustrates the point. The immature carpels seem broad for *subhastata* f. *typica,* but the lateral divisions of the leaf are short for *pumila.* In southwestern New Mexico (Hidalgo County) and in southeastern Arizona (Cochise County), forms of more or less intermediate character seem more numerous than specimens typical of either *subhastata* or *pumila.* To this category belong collections at Alamo Viejo, New Mexico (*Mearns* 78), Lordsburg, New Mexico (*Eastwood* 8553, 8581), and San Simon to Dragoon, Arizona (*Harrison and Kearney* 36–45).

In central Arizona subsp. *pumila* apparently intergrades extensively with subsp. *connata.* Specimens that differ from *pumila* in their relatively shallowly cleft leaf blades and resemble *connata* in having the indehiscent portion of the carpel relatively small and finely reticulate, but that approach *pumila* in their relatively short and broad carpels, occur frequently in the vicinity of Prescott (*Peebles, Harrison, and Kearney* 8852, 8893).

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[45] Type collection of *S. glabrescens* Woot. and Standl.

S. subhastata pumila apparently forms a connecting link between the Hastulatae and the Coccineae. Some specimens of *pumila* (*Metcalfe* 155, Mangas Springs, New Mexico; *Kearney and Leding* 7, Jackson, New Mexico) strikingly resemble *S. coccinea elata;* and in the absence of mature fruit it is often difficult to decide to which form such specimens should be referred. The characters of subsp. *pumila* are such as to suggest that it may have originated as a hybrid between *subhastata* and *coccinea*.

20. **Sphaeralcea caespitosa** Jones, Contr. West. Bot., 12:4. 1908.

Plant perennial, with a very thick, woody crown, densely white-pubescent with rather long, soft hairs, those of the stem 0.4–0.5 mm. long, with 12–15 rays. Stems few, decumbent or ascending, 8–20 cm. long, about 2 mm. in diameter at base. Leaf blades thickish, with veins rather prominent beneath, rhombic-ovate, at base strongly cuneate, at apex obtuse or acutish, 3–5-veined from the base, not lobed, very coarsely and irregularly dentate, the larger blades 2–4 cm. long and approximately as wide. Petioles rather slender, those of the lower leaves longer than the blade. Inflorescence racemiform, not more than 10-flowered, leafy below. Pedicels rather slender, the lower ones sometimes longer than the calyx. Calyx at anthesis 15 mm. high, with ovate-lanceolate, short-acuminate lobes nearly 3 times as long as the tube. Petals grenadine, 22 mm. long. Fruit approximately hemispherical, about ½ as high as the calyx. Carpels (pl. 11, *J*) about 13, thick, with firm, chartaceous walls, 3–5 mm. high and ⅗ to very nearly as wide, narrowly and very shallowly notched, the dehiscent portion ascending, broadly deltoid, very obtuse, muticous or mucronate, the indehiscent portion forming about ⅓ of the carpel, rather prominently and rather coarsely reticulate; attaching threads short. Ovules and seeds 1 or 2. Seeds sparsely pubescent.

Type locality.—"Wa Wa" (Wahwa Springs?), Beaver County, Utah, at an elevation of 6000 feet. Type (P) collected by M. E. Jones, June 25, 1906.

Geographical distribution and habitat.—Known only from the type collection, in western Utah. Grows "on very poor volcanic soil covering lava" (Jones).

Specimens examined.—Utah. Beaver County: Wa Wa, *Jones* in 1906 (C, CA, F, M, N, P, S).

This interesting little plant is presumably rare and local, having been collected only once. The structure of its carpels shows clearly its affinity to *S. munroana* (Doug.) Spach and *S. grossulariaefolia* (H. and A.) Rydb., but it is very distinct from these species in its dwarf stature, longer hairs of the stems, leaves, calyx, and carpels, simple, few-flowered inflorescence, and more deeply cleft calyx. A typical specimen of *grossulariaefolia* was collected, by Jones, at the same locality. The seeds of *caespitosa* are more deeply reniform and larger than is usual in the subgenus, attaining, at least when solitary, a diameter of 2 mm.

21. **Sphaeralcea parvifolia** A. Nelson, Proc. Biol. Soc. Wash., 17:94, 95. 1904.

S. marginata York; Rydberg, Bull. Torrey Club, 33:145–146. 1906.

S. arizonica Heller; Rydberg, Bull. Torrey Club, 40:59. 1913.

Plant perennial, with a large taproot and a stout woody crown, grayish or whitish canescent, usually densely so, at least when young, with hairs of varying length, those of the stem 0.15–0.35 mm. long, with 12–22 rays. Stems sev-

eral, erect or ascending, up to 100 cm. long, up to 5 mm. in diameter at base but usually more slender. Leaf blades usually thickish, with veins prominent beneath, flat or somewhat rugose, broadly deltoid or suborbicular (less typically subrhombic), at base subcordate to deeply cordate (less typically truncate or even subcuneate), at apex usually obtuse or almost truncate, usually 5-veined from the base, not lobed or shallowly 3-lobed near the middle with broad, rounded lobes (rarely deeply cleft), margin crenate, often finely and regularly so, the larger blades 2–4 cm. long and ⅔ as wide to wider than long. Petioles usually slender. Inflorescence many-flowered, narrowly thyrsoid-glomerate, the lower branches sometimes 5 cm. long but usually much shorter. Pedicels usually stout and shorter (often much shorter) than the calyx. Calyx densely pubescent on its whole outer surface or the pubescence much denser on the tube and margins of the lobes than elsewhere, at anthesis 4–8 mm. high, with deltoid and acute or ovate-lanceolate and short-acuminate lobes 1–2 times as long as the tube. Petals grenadine, 8–18 mm. long. Column usually glabrous or very sparsely pubescent. Fruit little higher than hemispherical to short truncate-conical, usually higher than the calyx and sometimes nearly twice as high. Carpels (pl. 12, *A*) 9–12, thickish, with chartaceous walls, 3–5 mm. high and ½–⅘ as wide, very shallowly and rather broadly notched, the dehiscent portion erect, ovate or deltoid-ovate, acutish, mucronate or short-cuspidate (seldom muticous), the indehiscent portion forming usually about ¼ of the carpel, finely and not prominently (often faintly) reticulate; attaching threads well developed and usually long. Ovules 1–3. Seeds usually 2, more or less pubescent.

Type locality.—Caliente, Lincoln County, Nevada. Type (R) collected by L. N. Goodding, May 22, 1902, No. 916.

Geographical distribution and habitat.—Western Colorado to eastern California, northwestern New Mexico, and central Arizona, at elevations of 2000–7000 (usually not lower than 4000) feet. Inhabits slopes and mesas, sometimes openings in pine forests, preferring dry, well-drained soil.

Specimens examined (selected).—COLORADO. Mesa County: Fruita, *Eastwood* 5177 (CA). Grand Junction, *Baker* 93[46] (A, C, G, M, N, P, S, Y). Utah-line, *Coville and Kearney* 2605 (N), *Trelease* 4398 (M). Montrose County: Paradox, *Walker* 189 (G, M, N, P, R, S, Y). La Plata County: La Plata Valley, *Brandegee* 1107 (C, M). Montezuma County: McElmo Canyon, *Vreeland* 860 (Y).

UTAH. Grand County: Cisco, *Jones* in 1895 (N, P, Y). Moab, *Jones* in 1915 (C). Wilson Mesa, *Rydberg and Garrett* 8386 (N, Y). Emery County: Green River, *Tidestrom* 1048 (N). Sevier County: Glenwood, *Ward* in 1875 (G, M, N). San Juan County: Abajo Mountains, *Rydberg and Garrett* 9301 (N, Y). Washington County: St. George, *Jones* 1660 (F, N, Y), *Parry* 25 (F, G, M, Y), *Tidestrom* 9286 (G, N, Y).

NEVADA. Elko County: Wells, *L. S. Rose* 32380 (CA). Humboldt County: Winnemucca, *Baker* 4809a (C). White Pine County: Ely, *A. E. Hitchcock* 1215 (N), *Jones* in 1923 (P). Washoe County: Reno, *Stokes* in 1900 (N, Y). Lincoln County: Caliente, *Goodding* 916, the type collection (G, M, N, P, R, Y), *Tidestrom* 9474 (F, M, N). Nye County: Monitor Range, *Tidestrom* 10983 (F, N). Esmeralda County: Goldfield, *Heller* 9617 (F, G, M, N, S, Y).

NEW MEXICO. San Juan County: Farmington, *Standley* 6875 (N). Tiznitzin, *Wooton* 2672 (N). McKinley County: Ojo Caliente, *Wooton* in 1906 (N, S). McKinley (or San Juan) County: Gallup to Shiprock, *Nelson* 10378 (C).

ARIZONA. Apache County: Carriso Mountains, *Standley* 7452 (G, M, N, Y).

[46] Type collection of *S. marginata* York.

Navajo Reservation, *Vorhies* 55 (C, G). Navajo County: Holbrook, *Ward* in 1901 (N, Y), *Zuck* in 1896 (C, N, Y). Coconino County: Flagstaff, *Macdougal* 120[47] (A, C, F, G, N, R, Y). Grand Canyon, *Condit* in 1912 (C), *Ferris and Duncan* 2245 (CA, S), *Rattan* in 1912 (C). Jacobs Lake, *Mathias* 657 (G, M, P). Tolchico, *Hanson* A246 (F, M, Y). Mohave County: Kingman, *Eastwood* 18074, in part (CA, N). Peach Spring, *Wilson* 12 (C). Pipe Spring, *Jones* 5272a (C, N, P, Y). Yavapai County: Ashfork, *Rusby* 538 (N, Y). Beaver Creek, *Purpus* 8239 (C, M, N). Camp Verde, *Mearns* 225 (Y). Hillside, *Jones* in 1903 (C, P, S). Prescott, *Peebles, Harrison, and Kearney* 4245 (N). Rio Verde, *Coues and Palmer* 495 (M). Gila County: Miami, *Kearney and Peebles* 9257 (N). Pinal County: Superior, *Kearney and Peebles* 9216 (N).

CALIFORNIA. Inyo County: Bishop Creek, *Jones* in 1926 (P). White Mountains, *Duran* 2623, in part (R).

S. parvifolia is nearly related to *S. munroana* (Doug.) Spach and there seems to be considerable intergradation between the two species where their ranges overlap in Utah and Nevada, but a large majority of the specimens are readily distinguished by the characters given in the key. Also, in *parvifolia*, the carpels are usually more shallowly notched and more finely and less prominently reticulate. The writer has seen no specimen from Arizona that could be mistaken for *munroana*. Specimens collected at Ely, Nevada (*Hitchcock* 1215, *Jones* in 1923), have the leaves cleft about halfway to the midvein as in some specimens of *S. munroana*, but the carpels are rather high, 2-seeded and short-cuspidate, characters of *parvifolia*.

Because of this relationship, the writer has included *parvifolia* in the section Munroanae, although it differs from other species of that section in its relatively high fruits, often surpassing the calyx, and higher, narrower, and more pointed carpels. In these particulars it seems intermediate between the Munroanae and the Fendlerianae, and, indeed, *parvifolia* somewhat resembles *S. incana* Torrey, of the Fendlerianae. The following characters serve, in general, to distinguish *parvifolia* from *incana*. Pubescence drying whitish or grayish (not yellowish); stems usually shorter, not exceeding 100 cm., less virgate, more often branched; leaf blades usually smaller, not more than 4 cm. long; inflorescence usually much shorter and fewer-flowered; pedicels usually shorter; column less pubescent, sometimes glabrous; fruit lower, often much lower; carpels usually mucronate or short-cuspidate with erect cusps, whereas in *incana* they are usually long-cuspidate with spreading cusps.

The type of *S. marginata* York (*Baker* 93) has the calyx very sparsely pubescent except at the base of the tube and on the margins of the lobes. In the types of *S. parvifolia* Nelson (*Goodding* 916) and *S. arizonica* Heller (*Macdougal* 120) the whole outer surface of the calyx is copiously pubescent, although the pubescence is denser at the base of the tube than elsewhere. Rydberg recognized *arizonica* as a species distinct from *marginata* on the basis of this character, but there is complete intergradation from one form to the other. Most of the specimens from Colorado and several from Utah have the calyx as in Baker's collection, but a specimen (*Eastwood* 5177) collected at

[47] Type collection of *S. arizonica* Heller.

Fruita, Colorado, very near the type locality of *marginata,* has a typical *arizonica* calyx.

There is considerable resemblance, in habit and foliage, between *S. parvifolia* and *S. ambigua* Gray, particularly the high-altitude form with contracted inflorescence (subsp. *monticola*). As a rule, however, *parvifolia* is readily distinguished from *ambigua* by its more numerous and smaller flowers and fruit equaling or surpassing the calyx. The carpels are not mistakable, those of *ambigua* being galeate and prominently reticulate. Part of a collection in the White Mountains, Inyo County, California, far beyond the usual range of *parvifolia* (*Duran* 2623, R), seems typical of that species; but specimens of the same number in other herbaria (C, CA, M, Y) look more like *ambigua monticola.* Since none of them have fruit, positive identification is not practicable. But another collection in Inyo County, at Bishop Creek (*Jones* in 1926), has fruit and the reduced reticulation and well-developed attaching threads of the carpels leave no doubt that it is *parvifolia.*

S. parvifolia is by far the most abundant species of *Sphaeralcea* on the high plateaus of central and northern Arizona, and Miss Alice Eastwood reported that between Kingman and Peach Springs the whole landscape was red with its flowers. A similar condition in the country between Prescott and Ashfork was noted by George J. Harrison. Grenadine color of the petals is almost universal in this species, the only exception known to the writer being a specimen with white petals, collected at Camp Verde, Arizona (*Mearns* 225).

22. **Sphaeralcea munroana** (Douglas) Spach, *in* Gray, Proc. Am. Acad., 22:292. 1887.[48]
Malva munroana Douglas, *in* Lindl., Bot. Reg., 16: t. 1306. 1830.
Nuttallia munroana Nutt., Jour. Acad. Phila., 7:16, 17. 1834.
Malvastrum munroanum Gray, Mem. Am. Acad., n. ser., 4:21. 1849.

Plant perennial, with a large taproot and well-developed, woody crown, usually bright green and rather sparsely pubescent but sometimes canescent, with short, soft, whitish hairs, those of the stem 0.20–0.25 mm. long, with 11–20 rays. Stems several, erect or ascending, up to 90 cm. long and up to 6 mm. in diameter at base. Leaf blades usually thin and with veins not very prominent beneath, very broadly ovate, flabelliform or subrhombic, at base subcuneate to subcordate (rarely pronouncedly cordate), at apex obtuse or truncate (rarely acutish), usually 5-veined from the base, usually distinctly but shallowly 3–5-lobed with obtuse or acutish lobes, margin crenate or dentate, usually coarsely so (rarely nearly entire), the larger blades 2–6.5 mm. long and ¾–1⅓ times as wide. Petioles usually slender. Inflorescence many-flowered, narrowly thyrsoid-glomerate, the lower branches usually not more than 3 cm. long. Pedicels usually rather stout and shorter (often much shorter) than the calyx. Calyx at anthesis 4–9 mm. high, with deltoid-ovate, acute (sometimes ovate-lanceolate, short-acuminate) lobes 1–2 times as long as the tube. Petals grenadine, 10–18 mm. long. Column sparsely pubescent or glabrescent. Fruit hemispherical, lower (but usually only slightly lower) than the calyx. Carpels (pl. 12, *B*) 10–12, thick, with firm, chartaceous walls, about 3 (rarely 4) mm. high and ¾ to very nearly as wide, shallowly and usually

[48] Gray was mistaken in assuming that the combination *Sphaeralcea munroana* was properly published by Spach (1834, p. 353), who names the plant "Sphaeralcée de Munro," giving *Malva munroana* Douglas as a synonym. The combination seems not to have been published formally until Gray himself did so, as here cited.

narrowly notched, the dehiscent portion erect or nearly so, broadly deltoid, very obtuse (seldom acutish), muticous or sometimes mucronulate, the indehiscent portion forming $\frac{1}{3}$–$\frac{3}{5}$ of the carpel, rather finely and usually rather prominently reticulate; attaching threads of varying length. Ovule and seed 1 (occasionally 2). Seeds more or less pubescent.

Type locality.—"Barren plains of the Columbia." Type (Kew) collected by D. Douglas in July, 1826.

Geographical distribution and habitat.—Wyoming to southwestern Montana and southern British Columbia, south to Utah, Nevada, and eastern California, at elevations of 1500–6500 feet. Inhabits dry plains and mountain sides, preferring light soils, often soils of volcanic origin.

Specimens examined (selected).—BRITISH COLUMBIA. Lake Osoyoos, *Macoun* 73168 (F, G, M, P).

MONTANA. Madison County: Monida, *Jones* in 1922 (P).

IDAHO. Latah County: Moscow, *Benson* 1643 (S). Nez Perce County: Lewiston, *Heller* 3246 (C, M, N, S, Y). Big Potlatch River, *Sandberg* et al. 302 (C, CA, G, M, N, S, Y). Lemhi County: Salmon, *Payson* 1774 (CA, G, M, Y). Fremont County: St. Anthony, *Merrill and Wilcox* 824 (G, N, Y). Bingham County: Blackfoot, *Palmer* 557 (N). Blaine County: Ketchum, *Nelson and Macbride* 1231 (C, F, G, M, N, P, S, Y). Picabo, *Macbride and Payson* 2986 (C, CA, G, M, N, P, S, Y). Ada County: Boise, *Clark* 58 (C, F, G, M, N, P, S, Y), *Wilcox* (G, N). Canyon County: Falks Store, *Macbride* 53 (C, F, G, M, N, S, Y). Lincoln County: Shoshone, *Nelson and Macbride* 1175 (G, M). Bear Lake County: Montpelier, *Nelson and Macbride* 1050 (G, M, S). Bannock County: Pocatello, *Eggleston* 9945 (G, N). Twin Falls County: Twin Falls, *Mathias* 781 (G, M, P, Y). Payette County: New Plymouth, *Macbride* 7132 (F).

WASHINGTON. Okanagan County: Okanagan River, *Cooper* (G). Spokane County: Spokane, *E. J. Palmer* 37849 (M, N, Y). Lincoln County: Davenport, *Benson* 1613 (S). Grant County: Wilson Creek, *Sandberg and Leiberg* 276 (C, CA, F, G, M, N, S, Y). Douglas County: Rock Island, *Thompson* 6757 (G, M). Chelan County: Wenatchee, *Whited* 1120 (N, Y). Adams County: Cow Creek, *Griffiths* 522 (N, Y). Columbia County: opposite Alkali (Oregon), *Howell* in 1882 (F, M, N, S). Walla Walla(?) County: on the Walla Walla, *Wilkes Exp.* 538 (N, Y). Yakima County: *Brandegee* 466 (C, M). Prosser, *Cotton* 1073b (G, N).

OREGON. Umatilla County: Pendleton, *Heller* 10168 (CA, F, M, N, S). Morrow County: Boardman, *Thompson* 4772 (G, M, N, S). Baker County: Baker, *Eggleston* 12631 (N). Grant County: John Day River, *Henderson* 5401 (CA, G, M, S). Jefferson County: Culver, *E. C. Johnston* in 1931 (CA). Malheur(?) County: Malheur Valley, *Leiberg* 2249 (C, F, G, N, P, Y). (?) County: Snake River, *Cusick* 2792 (C, F, G, M, N, P, Y).

WYOMING. Albany County: Laramie, *Nelson* 8908 (G, M, N, Y). Lincoln County: Alpine, *Payson and Armstrong* 3411 (P). Uinta County: Evanston, *Sanford* in 1883 (C).

UTAH. Cache County: Logan, *Smith* 2253 (G, S, Y). Summit County: Gogorza, *Garrett* 2283 (G, Y). Morgan County: Peterson, *Pammel and Blackwood* 3896 (G). Salt Lake County: Salt Lake City, *Jones* 1015 (Y). Tooele County: Grantsville, *Jones* 25351 (M, P). Wasatch County: Midway, *Garrett* 1326 (G). Sevier County: Redmond, *Eggleston* 11129 (N). (?) County: Wasatch Mountains, *Watson* 197 (G, N, Y).

NEVADA. Elko County: Ruby Valley, *Watson* 198 (G, N, Y). Wells, *Jones* 25348 (M, P). Eureka County: Palisade, *Brandegee* in 1885 (N). Humboldt(?) County: *Torrey* 55 (Y). Washoe County: Reno, *Jones* in 1897 (P,

S). Ormsby County: Carson City, *Anderson* 86 (G), in 1864 (N). Lincoln County: Panaca, *Jones* in 1912 (CA, P, R).

CALIFORNIA. Placer County: Squaw Creek, *Stacey* in 1922 (CA).

The relationship between *S. munroana* and *S. parvifolia* was discussed under *parvifolia.* Northern specimens of *munroana* that simulate *parvifolia* in their denser pubescence and in having the leaf blades rather thick, with veins prominent beneath, and more finely crenate on the margin, have been collected in Idaho (*Macbride* 7132 at New Plymouth, *Wilcox* at Boise) and in Oregon (*Heller* 10168 at Pendleton, *Leiberg* 2249 in the Malheur Valley). But most of the intermediate specimens, as was noted under *parvifolia,* come from Utah and Nevada, e.g., *Jones* in 1912, collected at Panaca, Nevada, near the type locality of *parvifolia,* which it resembles except in shape of the carpels.

Another nearly related species is *S. grossulariaefolia* (Hook. and Arn.) Rydberg, the typical form of which differs from *munroana* chiefly in its denser pubescence and more dissected, often pedate, leaf blades. Part of a collection at Lewiston, Idaho (*Heller* 3246), is so nearly intermediate, being densely soft-canescent and having deeply cleft and coarsely toothed leaves, as to suggest that it may be an interspecies hybrid. Other specimens that may be *munroana* × *grossulariaefolia* were collected at Salmon, Idaho (*Payson* 1774), and in Humboldt(?) County, Nevada (*Torrey* 55).

Specimens with rather deeply cleft leaves, but differing from *grossulariaefolia* in their sparse pubescence, were collected at Laramie, Wyoming (*Nelson* 8908), Logan, Utah (*Smith* 2253), and in the Wasatch Mountains, Utah (*Watson* 197). These mark the transition to subsp. *subrhomboidea.* A collection at Boise, Idaho (*Clark* 58), is remarkable in being densely soft-canescent, almost tomentose. A specimen with nearly entire leaf blades was collected at Blackfoot, Idaho (*Palmer* 557). In *munroana,* as in *caespitosa,* the seed, when solitary, is rather large for the subgenus, reaching a diameter of 2 mm.

22*a*. **Sphaeralcea munroana subrhomboidea** (Rydberg) comb. nov.

S. subrhomboidea Rydberg, Bull. Torrey Club, 40:59, 60. 1913.

? *Malva creeana* Graham, *in* Curtis, Bot. Mag., 65: t. 3698. 1839.

? *Sphaeralcea creeana* Sprague and Sandwith, Bull. Kew (1929):203, 204. 1929.

Differs from the typical form of *S. munroana* as follows: leaf blades subcuneate to (usually) strongly cuneate at base, cleft more than halfway to the midvein or 3-parted, the lateral divisions and, sometimes, the mid-lobe also, less deeply cleft.

Type locality.—Near Midway, Wasatch County, Utah. Type (Y) collected by E. C. Carlton and A. O. Garrett, July 6, 1905, No. 6691.

Geographical distribution and habitat.—Southwestern Wyoming and northern Utah to eastern Oregon and northern Nevada, at elevations of 4500–6000 feet. Inhabits "valleys" (Rydberg).

Specimens examined.—WYOMING. Uinta County: Evanston, *Sanford* 280 (C).

UTAH. Boxelder County: Promontory Point, *Watson* 199 (G, N, Y). Summit County: Kimball Ranch, *Garrett* 5908 (R). Wasatch County: Hot Pots, *Garrett* 1327 (R). Midway, *Carlton and Garrett* 6691, the type collection (G,

N, R, Y). Morgan Power Plant, *Garrett* 4004 (F). P. V. Junction, *Jones* in 1883 (P). Utah County: Soldier Summit, *Eastwood* 7697 (CA). Juab County: Parley, *Eaton* 58 (CA).

NEVADA. Alder Creek Ranch, northern Nevada, *Griffiths and Morris* 278 (N, Y).

OREGON. Grant(?) County: John Day River, *Bailey* 66 (N).

This form seems to be most frequent in the Wasatch Mountain region. The plant is always bright green and sparsely pubescent, differing in these respects and in the strongly cuneate leaf bases from *grossulariaefolia,* which it resembles in the deeply dissected leaf blades. The type collection of *subrhomboidea* is the most distinct from typical *munroana,* having the most deeply dissected leaves, and carpels that are orbicular in outline and small for the species (only 2.5 mm. in diameter). Some of the specimens referred by the writer to this subspecies are more or less intermediate, having the leaves, at most, deeply cleft. Those on which there is fruit (*Bailey* 66, *Watson* 199) have higher and narrower carpels than the type, 3 and 3.5 mm. high, respectively. The specimen from northern Nevada (*Griffiths and Morris* 278) is dwarf, with stems not more than 20 cm. long, and has the leaf blades 3-parted, with the divisions deeply cleft. It is atypical in having the leaf blades scarcely cuneate, as is also true of Bailey's much larger specimen from Oregon.

The identity of the plant illustrated in Curtis Botanical Magazine (1839, t. 3698) under the name *Malva creeana* Graham has never been established. Gray (1887, p. 291) referred it, doubtfully, to *Sphaeralcea pedata* Torrey, and Rydberg (1913, p. 58) to *S. grossulariaefolia.* Sprague and Sandwith (1929, p. 204) concluded that it is a distinct species, and published the combination *Sphaeralcea creeana.* But, if the cultivated plant from which the plate cited was prepared came originally from the northwestern United States, and if it is faithfully portrayed, it can scarcely be other than *munroana subrhomboidea.* The leaves, as represented in this plate, are precisely as in the type collection of *S. subrhomboidea* Rydb., although the latter has shorter stem hairs and shorter and broader calyx lobes than are shown in the illustration of *M. creeana.*

23. **Sphaeralcea grossulariaefolia** (Hook. and Arn.) Rydberg, Bull. Torrey Club, 40:58. 1913.

Sida grossulariaefolia Hook. and Arn., Bot. Beechey Voy., 326. 1840.

Malvastrum grossulariaefolium Gray, Mem. Am. Acad., n. ser., 4:21. 1849.

Malvastrum coccineum grossulariaefolium Torrey, *in* Stansbury Exped., 384. 1852.

Sphaeralcea pedata Gray (in part), Proc. Am. Acad., 22:291. 1887. Not Torrey, 1849.

Plant perennial with a large taproot and woody crown, densely whitish-canescent or subtomentose, at least on the younger parts, with short, soft hairs, those of the stem 0.15–0.30 mm. long, with 11–21 rays. Stems few, erect or ascending, up to 110 cm. long, up to 4 mm. in diameter at base. Leaf blades thin or thickish, with veins often rather prominent beneath, deltoid or broadly ovate in outline, at base usually more or less cordate but sometimes truncate or subcuneate, at apex obtuse or acutish, 5-veined from the base, pedately deeply cleft, parted or divided with cuneate-obovate divisions that are usually deeply cleft or parted and coarsely and irregularly few-toothed, the mid-lobe

10–20 mm. wide at the widest point, the larger blades 2–4.5 cm. long and approximately as wide. Petioles slender or rather stout, those of the lower leaves nearly as long as to longer than the blade. Inflorescence usually many-flowered, narrowly thyrsoid-glomerate, the lower branches up to 6 cm. long but usually much shorter. Pedicels slender or rather stout, usually much shorter but sometimes considerably longer than the calyx. Calyx at anthesis 5–8 mm. high, with ovate-lanceolate, short-acuminate (sometimes deltoid-ovate, acute) lobes 1–2 times as long as the tube. Petals grenadine, 8–20 mm. long. Column glabrous to copiously pubescent. Fruit hemispherical, lower than or about equaling the calyx. Carpels (pl. 12, *C*) about 12, with chartaceous walls, 2.5–3.5 mm. high and approximately as wide, often nearly orbicular in outline, shallowly and usually narrowly notched, the dehiscent portion ascending or erect, usually very broadly deltoid-ovate, very obtuse (or sometimes acutish) at apex, muticous or mucronulate, the indehiscent portion forming 2/5–3/5 of the carpel, finely but often rather prominently reticulate; attaching threads short or often, apparently, wanting. Ovules 1 or 2. Seed usually 1, glabrous to rather copiously pubescent.

Type locality.—"Bamcoch River, Snake Country."[49] Type specimen (Kew) collected by W. F. Tolmie.

Geographical distribution and habitat.—Idaho and Utah to south-central Washington and northern California, usually at elevations of 4000–6000 feet. Inhabits dry plains and hillsides, often on volcanic soils.

Specimens examined.—IDAHO. Valley County: Payette Lake, *Jones* 6213 (N). Power(?) County: "Snake Country," Bannock(?) River, *Tolmie,* the type collection (G, Y). Owyhee County: Reynolds Creek, *Macbride* 1020 (C, F, G, M, N, P, S, Y).

WASHINGTON. Yakima County: Priest Rapids, *Cotton* 1393 (G, N).

OREGON. Harney County: Coleman Valley, *Coville and Leiberg* 72 (N).

UTAH. Cache County: Logan, *Garrett* 2753 (Y). Salt Lake County: Parley Canyon, *Garrett* 2131 (G). Salt Lake City, *Stokes* in 1900 (N, S, Y). Utah County: Provo, *Garrett* 3312 (R), 3855 (F). West of Utah Lake, *Decker* 26–1 (Y). Tooele County: *Garrett* 2769 (G), 5329 (CA). Dutch Mountain, *Jones* 6202 (M, P). Ibapah, *Cottam* 3151 (M), 3220 (F). Wendover, *Eastwood and Howell* 368 (CA, N). Sanpete County: Manti, *Eastwood and Howell* 599 (CA). Millard County: Garrison, *Jones* in 1906 (P). Piute County: Marysvale, *Rydberg and Carlton* 6956 (Y). Marysvale Canyon, *Eastwood and Howell* 636 (CA, N). Beaver County: Milford, *Jones* in 1880 (S), *Rydberg and Garrett* 6269 (Y), *Stokes* in 1903 (N). Wahwa Springs, *Jones* in 1906 (P). Garfield(?) County: Sevier River Canyon, *Eastwood and Howell* 631 (CA, N). Iron County: Modena, *Goodding* 1005 (G, M, N, P, Y).

NEVADA. Elko County: Elko to Wells, *Eastwood and Howell* 267a (CA, N). Lander County: Austin, *A. E. Hitchcock* 691 (N). Toyabe Range, *Kennedy* 4061 (S). Pershing County: Lovelock to Imlay, *Eastwood and Howell* 159 (CA, N).

CALIFORNIA. Lassen County: Hot Springs Peak, *Monnet* 803 (CA, N).

This widely distributed species, which reaches its maximum abundance, apparently, in Utah, closely resembles *munroana* in the characters of its carpels. It differs from that species chiefly in its dense, whitish pubescence and pedate, usually more or less cordate, leaves. Less canescent specimens, such as *Garrett* 3312, collected at Provo, Utah, seem to approach *munroana subrhomboidea.* Specimens that may be hybrids between *grossulariaefolia* and

[49] The Bannock River, Power County, Idaho, probably is meant.

munroana were mentioned under the latter species. A dwarf form of *grossulariaefolia,* with stems not exceeding 25 cm. long, seems to be rather frequent, having been collected at Salt Lake City, Utah (*Stokes* in 1900), at Wendover, Utah (*J. T. Howell* 7951), and in Lander County, Nevada (*Kennedy* 4532), the last belonging to subsp. *pedata.* Stokes's specimens have unusually small flowers, densely clustered in a subcapitate inflorescence.

23a. Sphaeralcea grossulariaefolia pedata (Torrey) comb. nov.

S. pedata Torrey, *in* Gray, Mem. Am. Acad., n. ser., 4:23. 1849.

Differs from the typical form of *S. grossulariaefolia* as follows: carpels (pl. 12, *D*) higher and narrower, broadly ovate in outline, 3/5–3/4 as wide as high, more pointed, sometimes mucronate or even short-cuspidate, frequently 2-seeded. Plant often less canescent.

Type locality.—"Moving Fork, 1st Camp, Utah." Type (Y) collected by Fremont's Expedition in 1845–1847, No. 411.

Geographical Distribution and Habitat.—Eastern Oregon to western New Mexico and central Arizona, at elevations of 2000–8000 feet. Inhabits mesas and mountain sides, often, at the higher elevations, growing among junipers and pinyons.

Specimens examined.—OREGON. Wheeler County: John Day River, *Peck* 9996, in part (F). Harney County: *Henderson* 8855 (CA).

UTAH. Garfield County: near Bryce Canyon, *Eastwood and Howell* 796 (CA, N). Washington County: Pine Valley, *Eastwood and Howell* 1226 (CA, N). Zion Canyon, *Garrett* 2680 (Y), *Jones* in 1923 (P). ? County: Moving Fork, *Fremont* 411, the type collection (G, N, S, Y).

NEVADA. Pershing County: Lovelock to Imlay, *Eastwood and Howell* 136 (CA, N). White Pine County: Mount Wheeler, *Cottam* 3270 (M). Lander County: Austin to Big Creek, *Kennedy* 4532 (S). Battle Mountain, *Eastwood and Howell* 171 (CA, N). Round Mountain, *Phares* in 1915 (S). Clark County: Charleston Mountains, *Jaeger* in 1926 (CA, P). *Purpus* in 1898 (C).

NEW MEXICO. San Juan County: Tiznitzin, *Wooton* in 1904 (N). McKinley County: along Nutria Creek, *Newberry* in 1859 (N). Sierra County: Kingston, *Metcalfe* 930 (N). ? County: without locality, *Palmer* in 1869 (G).

ARIZONA. Navajo County: Hotevilla, *Harrison* 8719 (N). Navajo (or Coconino) County: Little Colorado River, *Ward* in 1901 (N, Y). Coconino County: Cameron, *Hanson* A247 (F, M). Grand Canyon, *Eastwood* 3700 (CA), *A. E. Hitchcock* 73 (N). Coconino (or Mohave) County: Diamond Creek Canyon, *Wilson* 11 (C). Yavapai County: Beaver Creek, *Wolf* 2432 (CA, G, S). Cornville, *W. W. Jones* 31 (G). Oak Creek, *Fulton* 5908 (N). Gila County: Roosevelt, *Harrison* 7785 (N), *Wilson* in 1917 (C). Pinal County: Sacaton, *Peebles and Harrison* 1653 (Sac). Superior, *Peebles and Harrison* 4039 (Sac). Yuma County: Buckskin Mountains, *Jones* 6063d (N).

This subspecies is, in the main, of more southern range than typical *grossulariaefolia,* rarely occurring north of central Utah and Nevada. The type collection of *S. pedata* Torrey (*Fremont* 411) shows the extreme departure from the more northern and presumably typical form of *grossulariaefolia,* having 2-seeded, mucronate, or short-cuspidate carpels much like those of *S. rusbyi* Gray, although the plant differs from the latter in its more copious pubescence, shorter, many-rayed hairs and more numerously flowered, thyrsoid-glomerate inflorescence. In respect to the carpels, subsp. *pedata* bears much

the same relation to typical *grossulariaefolia* as does *parvifolia* to *munroana*, but the two latter species are distinguishable by their vegetative characters, also.

All fruiting specimens from Arizona and New Mexico have the relatively high, narrow, and pointed carpels of the subspecies, so that it has seemed safe to refer all specimens from those states to *pedata*, even though they lack fruit. In Nevada, however, specimens with carpels of typical *grossulariaefolia* and of subsp. *pedata* have been collected at the same locality. Since the two forms can be distinguished only by the characters of the fruit, specimens from Utah and Nevada lacking fruit are omitted from the list, with the exception of Jaeger's collection in the Charleston Mountains, Nevada.

Specimens from the Charleston Mountains in southern Nevada (*Purpus* in 1898, *Jaeger* in 1926) have an exceptionally deeply cleft calyx, with lobes 3 times as long as the tube, but seem to be typical otherwise. Purpus's specimen has good *pedata* carpels. A peculiar dwarf form with stems not more than 6 cm. long, leaf blades merely deeply cleft and few flowers in a dense, subcapitate inflorescence, was found at Tiznitzin in northwestern New Mexico (*Wooton* in 1904). Specimens collected at the Grand Canyon, Arizona (*Hitchcock* 73), and in Diamond Creek Canyon, Arizona (*Wilson* 11), have exceptionally few and large flowers and are very untypical in the open character of the inflorescence. Neither specimen has fruit and the identification is uncertain. The specimens from Oregon have good *pedata* carpels but in other respects seem to approach *munroana*.

At the southern edge of the range of subsp. *pedata*, the Gila River region in Arizona, occasional specimens with more open inflorescence suggest intergradation, or possibly hybridization, with *S. rusbyi gilensis*, as was mentioned in the discussion of that form. One of these (*Harrison* 7785) differs from either form in its extremely short and dense, yellowish (not whitish) canescence. In the Gila River region, subsp. *pedata* occurs at much lower elevations than elsewhere in its range. Some of the specimens from low altitudes were probably strays, brought down by flood waters from higher country. This was certainly true of a solitary plant that grew in the temporarily dry bed of the river at Sacaton, Arizona, elevation 1300 feet (*Peebles and Harrison* 1653).

24. **Sphaeralcea digitata** (Greene) Rydberg, Bull. Torrey Club, 40:58, 59. 1913.

Malvastrum digitatum Greene, Leaflets, 1:154. 1905.

Plant perennial, with a stout or rather slender taproot and woody crown, more or less canescent, with short, very slender-rayed hairs, those of the stem 0.25–0.30 mm. long, with 8–20 rays. Stems few, decumbent, ascending or nearly erect, up to 55 cm. long but usually much shorter, up to 3 mm. in diameter at base but usually more slender. Leaf blades rather thin, with veins somewhat prominent beneath, 5-veined from the base, pedately divided or nearly so, with the primary lateral divisions so deeply parted as to give the appearance of a 5-parted leaf, all the divisions oblanceolate or narrowly obovate, at base cuneate, at apex obtuse or acutish, often mucronulate, the mid-lobe not more than 5 mm. wide and not much longer than the primary lateral divisions, all the divisions entire or (the mid-lobe especially) coarsely and irregularly

few-toothed or cleft, the larger blades 1.5–4 cm. long and about equally wide. Petioles slender, those of the lower leaves ½–¾ as long as the blade. Inflorescence usually 10–20-flowered, narrowly subthyrsoid with often only the lowest nodes bearing more than 1 flower, the lowest branches not more than 2 cm. long. Pedicels mostly stout and much shorter than the calyx. Calyx at anthesis 3.5–7 mm. high, with ovate-lanceolate, acuminate lobes 1–1½ times as long as the tube. Petals grenadine, 8–14 mm. long. Anthers dark red or purple, rarely cream-colored. Column more or less pubescent. Fruit somewhat higher than hemispherical, wider than high, somewhat lower than the calyx. Carpels (pl. 12, *E*) 9–13, thickish, with chartaceous walls, 3–4 mm. high and ⅗–⅘ as wide, shallowly and rather narrowly notched, the dehiscent portion erect or nearly so, deltoid, acute or acutish, muticous to short-cuspidate, the indehiscent portion forming ⅓–½ of the carpel, finely and usually not prominently reticulate; attaching threads well developed, long or short. Ovules and seeds 1 or sometimes 2. Seeds more or less pubescent.

Type locality.—Kingston, Sierra County, New Mexico, at an elevation of 6600 feet. Type (N) collected by O. B. Metcalfe, June 3, 1904, No. 941.

Geographical distribution and habitat.—Central and western New Mexico to southeastern Utah and eastern Arizona, at elevations of 4000–7000 feet. Inhabits well-drained slopes, sometimes among junipers or pines.

Specimens examined.—UTAH. San Juan County: Bluffs, *Rydberg and Garrett* 9907 (N, Y), 9957 (Y).

NEW MEXICO. McKinley County: Agua Azul, *Rothrock* 138 (N).[50] Fort Wingate, *Matthews* in 1882 (G). Socorro County: Puertecito, *Wooton* 2675 (N). San Antonio, *Wooton* 3850 (N). Water Canyon, Magdalena Mountains, *Herrick* 33 (F). Catron County: Patterson, *Wooton* in 1900 (N). Reserve, *Kearney and Leding* 9 (F, N, Y). Sierra County: Berendo Creek, *Metcalfe* 889 (M, NM). Chiz, *Wooton* in 1904 (N). Hot Springs, *Mulford* 1143 (Y). Kingston, *Metcalfe* 941, the type collection (CA, F, G, M, N, NM, P, Y). Otero County: Sacramento Mountains, *Earle* 556 (Y). Dona Ana County: Organ Mountains, *Wooton* in 1893 (N), in 1905 (C, G, N, Y).

ARIZONA. Apache County: Nitsie Canyon, *Vorhies* 112 (C, G), without number (M, Y). Springerville, *Ferris* 1219 (S), 1234 (S). Apache(?) County: White Mountains, *Griffiths* 5278 (M, N). Coconino County: San Francisco Mountains, *Anderson* (M).

This species is related to *grossulariaefolia*, differing therefrom in the following characters: stems usually shorter and more slender; leaf blades with narrower, oblanceolate or narrowly obovate divisions, the mid-lobe seldom more than 5 mm. wide; inflorescence fewer-flowered, racemiform or subthyrsoid; anthers usually dark red or purple. The contrasting characters, in *grossulariaefolia*, are: leaf blades with the divisions broadly obovate, the mid-lobe 10–20 mm. wide; inflorescence many-flowered, thyrsoid-glomerate; anthers usually cream-colored. New Mexican specimens that approach *grossulariaefolia* in having the divisions of the leaf blade wider, the mid-lobe 10–15 mm. wide, but that are of *digitata* character in the relatively simple and few-flowered inflorescence, were collected at Berendo Creek (*Metcalfe* 889), Puertecito (*Wooton* 2675), San Antonio (*Wooton* 3850), and in the Organ Mountains (*Wooton* in 1893).

[50] This number, in other herbaria (F, G), is *S. coccinea*.

24*a*. **Sphaeralcea digitata tenuipes** (Woot. and Standl.) comb. nov.

Malvastrum coccineum var. Gray, Pl. Wright., 1:17. 1852.

Sphaeralcea pedata angustiloba Gray, Proc. Am. Acad., 22:292. 1887.

S. tenuipes Wooton and Standley, Contr. U. S. Nat. Herb., 16:148. 1913.

Differs from the typical form of *S. digitata* as follows: plant more often sparsely pubescent and bright green; leaf blades often thinner, with the divisions more often acutish; inflorescence racemiform, with seldom more than one flower to a node, usually fewer- (not more than 12-) flowered; pedicels more slender and elongate, the lower ones longer than the calyx, often 2 and sometimes 4 times as long; flowers usually larger, the calyx 6–10 mm. high and the petals 12–19 mm. long; petals often rather narrow; calyx usually more deeply cleft, with lobes 1½–2 times the length of the tube; carpels (pl. 12, *F*) sometimes more prominently reticulate.

Type locality.—Tortugas Mountain, near Las Cruces, Dona Ana County, New Mexico. Type (N) collected by P. C. Standley, May 6, 1906.

Geographical distribution and habitat.—Western Texas, southern New Mexico, and northwestern Chihuahua, at elevations of 3500–5000 feet. Inhabits rocky, treeless slopes.

Specimens examined.—TEXAS. Hudspeth County: *Cory* 2049 (F, N). Hueco Pass, *Whitehouse* 8403 (F). Sierra Blanca, *Jones* 26328 (M, P). El Paso County: El Paso, *Bigelow* (Y), *Dunn* in 1881 (C), *Ferris and Duncan* 2399 (S), *Hanson* 45 (G, N), without number (M, Y), *Jones* 3745 (F, N, P, Y), *Mulford* 220 (M, Y), *Purpus* in 1906 (C), *Rose and Fitch* 17887 (M, N, Y), *Stearns* 89 (N), *Thurber* 177 (G), *Wright* 1328[51] (C, G, M, N, Y). Presidio County: Chinati Mountains, *Young* 60 (M). Presidio, *Wright* 42 (G, M, N, Y). Maverick County: Eagle Pass, *Plank* in 1893 (Y).

NEW MEXICO. Dona Ana County: El Paso to Monument 53, *Wagner* 992 (N). Organ Mountains, *Wooton* in 1894 (N). Tortugas Mountain, *Kearney and Leding* 34 (N, Y), *Leding* in 1932 and 1933 (F, N, Y), *Standley* in 1906, the type collection (N, NM), *Wooton* in 1894 (N), in 1902 (C, N, P, Y), *Wooton and Standley* in 1908 (N). Hidalgo County: Stein Pass, *Purpus* 4438 (C).

CHIHUAHUA. Corralitos to El Paso, *Thurber* 733 (G, Y), 741 (G, Y). Juarez, *Pringle* 9446 (G, N). Rio Santa María, *Schott* (F). Sierra Madre (east of), *Schott* 10 (Y), 111 (G, Y).

The extreme form, characterized by sparse pubescence, a racemiform inflorescence and long, slender pedicels, seems very different from the more western, typical form of *digitata*, but there is such complete intergradation that the assignment of many specimens to one or the other form is almost purely arbitrary. Moreover, the best character for distinguishing the subspecies is largely a seasonal one. In September, 1932, A. R. Leding and the writer found numerous plants on Tortugas Mountain, New Mexico, the type locality of *S. tenuipes* (*Kearney and Leding* 34). All these had the sparse pubescence and thin leaves of subsp. *tenuipes*, but without exception the pedicels were stout and much shorter than the calyx, as usually occurs in typical *digitata*. A few weeks later, after heavy rains had caused new growth to start, and again in the early spring of 1933, Mr. Leding collected many specimens at the same locality, and all these had the long, slender pedicels

[51] Probably the type collection of *S. pedata angustiloba* Gray. The specimen of this number in the Gray Herbarium is labeled as from Chihuahua.

of the subspecies. Even in the type collection of *Malvastrum digitatum* Greene, some of the lower pedicels are very slender and are distinctly longer than the calyx. In view of the unreliability of this character, the writer has referred to subsp. *tenuipes* most of the specimens of *digitata* from the El Paso region in Texas and New Mexico, including several with short pedicels, since they resemble the type of that form in their relatively thin leaves, sparse pubescence, simple inflorescence, and large flowers.

S. digitata tenuipes has often been confused with *S. pedatifida* Gray, even by Gray himself, who identified specimens collected by Wright near El Paso as *Malvastrum pedatifidum* (1852, p. 17; 1853, p. 20). The latter, however, is a wholly different plant, not known to occur west of the Pecos River, although, apparently, the ranges of *pedatifida* and *digitata tenuipes* meet at Eagle Pass, Texas.[52] Specimens of *tenuipes* with exceptionally narrow, oblanceolate petals have been collected on Tortugas Mountain, New Mexico (*Wooton* in 1902, in part, *Wooton and Standley* in 1908), and west of El Paso (*Wagner* 992). Another specimen from the vicinity of El Paso (*Stearns* 89) has unusually high and narrow carpels, with cusps 1 mm. long.

25. **Sphaeralcea leptophylla** (Gray) Rydberg, Bull. Torrey Club, 40:59. 1913.

Malvastrum leptophyllum Gray, Pl. Wright., 1:17. 1852.

Plant perennial, with a long, stout taproot and a stout woody crown, silvery-lepidote with short, many-rayed, appressed hairs of which the rays are united ¼ or more of their length, forming a fringed scale, hairs of the stem 0.15–0.30 mm. long, with 20–30 rays. Stems several or numerous, decumbent, ascending or erect, up to 50 cm. long, up to 3 mm. in diameter at base but usually more slender. Leaves sometimes fascicled in the lower axils, the blades thick or thickish, with midvein prominent beneath, usually conduplicate or with the margin revolute, the upper ones entire, linear or narrowly oblanceolate, at apex obtuse or acutish and usually cartilaginous-apiculate, the lower ones 3-divided or very nearly so, with the mid-lobe 1.5–3 mm. wide and 1–2 times as long as the lateral divisions, one or more of the divisions sometimes 1- or 2-cleft, the larger blades 1.5–3.5 cm. long. Petioles slender, usually less than ⅓ as long as the blade. Inflorescence racemiform, with long internodes, with not more than 12 and usually fewer flowers, appearing naked throughout or leafy at the base only. Pedicels usually slender, much shorter than to twice as long as the calyx. Involucel often persistent until maturity of the fruit, of 3 thickish bractlets. Calyx at anthesis 4.5–7 mm. high, with deltoid-ovate, acute, or ovate-lanceolate, short-acuminate, often rather strongly ribbed lobes 1–1½ times as long as the tube. Petals grenadine, 9–15 mm. long. Anthers and pistils red or purplish. Column more or less pubescent. Fruit hemispherical, about ⅔ as high as the calyx. Carpels (pl. 12, *G*) 7–9, very thick, with coriaceous walls, 3–3.5 mm. high, about ⅘ as wide, very shallowly and rather narrowly notched, the dehiscent portion ascending, triangular or nearly quadrangular, obtuse or acutish at apex, muticous or mucronulate (rarely strongly mucronate), with an internal, palate-like fold near the base dorsally, the indehiscent portion forming ⅔–¾ of the carpel, much wider than the dehiscent portion, very prominently and usually

[52] Assuming that a specimen of *digitata tenuipes* collected by Plank (Y) is correctly labeled in respect to locality. If so, it may have been a stray that grew from seed brought down the Rio Grande when in flood.

coarsely reticulate, moderately rugose or slightly tuberculate dorsally; attaching threads usually rather long. Ovule and seed 1. Seeds sparsely pubescent or glabrous.

Type locality.—"Between W. Texas and El Paso, New Mexico." Type (G?) collected by C. Wright in 1851.

Geographical distribution and habitat.—Southwestern Colorado and southeastern Utah to western Texas, southern New Mexico, northeastern Arizona, and Sonora or Chihuahua, at elevations of 4000–6000 feet. Inhabits dry, rocky hills and mesas, growing in shallow soils, underlain by hardpan or rock.

Specimens examined.—COLORADO. Archuleta County: San Juan River, *Brandegee* 1118 (C).

UTAH. Grand County: Cisco, *Jones* in 1899 (P). Moab, *Jones* in 1913 (N), *Rydberg and Garrett* 8432 (G, N, Y). Emery County: San Rafael Swell, *Jones* in 1914 (C, N, P, S). San Juan County: McElmo Creek, *Eastwood* 6119 (Y). San Juan River,[53] *Newberry* in 1859 (N), *Rydberg and Garrett* 9956 (M, Y). Kane County: Kanab, *Thompson* (G). (?) County: Court House Wash, *Eastwood* in 1892 (G, M, N), *Jones* in 1913 (P).

TEXAS. Pecos County: Fort Stockton, *Kearney and Harrison* 14 (N). (?) County: Escondido Springs, *Wright* 882 (M, N). Val Verde(?) County: Eagle Pass to Pecos River, *Havard* 42 (G, N).

NEW MEXICO. San Juan County: Farmington, *Osterhout* 6949 (P), *Standley* 6946 (N), *Wooton* 2677 (N). Chaves County: Roswell, *Wooton* in 1905 (N, Y). Lincoln County: Carrizozo, *Kearney and Leding* 28 (F, N), 29 (N, Y), *Wooton* 2668 (G, N). Socorro County: Socorro, *Nelson* 11457 (C), *Plank* (Y). Socorro Mountain, *Herrick* 757 (N). Socorro (or Dona Ana) County: San Andreas Mountains, *Wooton* in 1913 (N). Grant County: Apache Teju, *Mulford* 964 (M). Lone Mountain, *Mulford* 610 (M, Y). Dona Ana County: Dripping Spring, *Child* 520 (M).

ARIZONA. Apache County: Carriso Mountain, *Standley* 7443 (C, F, G, M, N, Y). Navajo County: Holbrook, *Ward* in 1901 (N, Y), *Wooton* in 1892 (N), *Zuck* in 1897 (M, N, Y). Pinedale, *Hough* 110 (N). Silver Creek, *Zuck* 45 (N). Coconino County: Cameron, *Hanson* A244 (F, M, Y). Lees Ferry, *Jones* in 1890 (M, N).

CHIHUAHUA OR SONORA. Las Playas and Ojo de Vaca, *Thurber* 339 (G).

This species is strikingly different from all other North American *Eusphaeralceae* in appearance and in the character of its pubescence. It resembles *digitata* most in aspect, but its thick, coriaceous carpels are very similar to those of *coccinea*, its nearest relative. In view of this relationship, it is interesting that *leptophylla*, unlike *coccinea*, has a well-developed involucel of 3 bractlets, like most of the species of *Eusphaeralcea*. In fact, the involucel is exceptionally persistent in this species.

Superficially, all the specimens are similar in pubescence, but, upon close examination, the hairs are found to vary from fringed scales in which the diameter of the undivided central portion much exceeds the length of the free portion of the rays, to the converse condition. New Mexican specimens that have the rays relatively free were collected near Carrizozo (*Kearney and Leding* 29, *Wooton* 2668) and in the San Andreas Mountains (*Wooton* in 1913). Another specimen collected near Carrizozo (*Kearney and Leding* 28) has the

[53] Possibly in northwestern New Mexico or southwestern Colorado.

scale-like pubescence typical of the species. A collection at Dripping Spring, New Mexico (*Child* 520), has the hairs of the calyx longer and less united than is usual in the species. Occasionally, the flowering stems are borne at intervals on long, woody, nearly horizontal roots.

26. **Sphaeralcea coccinea** (Pursh) Rydberg, Bull. Torrey Club, 40:58. 1913.

Cristaria coccinea Pursh, Fl. Am. Sept., 2:453, 454. 1814.

Malva coccinea Nutt., Gen., 2:81, 82. 1818.

Sida(?) coccinea D. C., Prodr., 1:465. 1824.

Malvastrum coccineum Gray, Mem. Am. Acad., n. ser., 4:21, 24. 1849.

Plant perennial with a slender or stout taproot and with or without a distinct crown, usually rather densely grayish or whitish pubescent, with stiff, rather long hairs, those of the stem 0.3–0.6 (rarely nearly 1.0) mm. long and with 7–20 rays that are united near the base. Stems usually decumbent, up to 50 (usually not more than 20) cm. long, up to 3.5 (usually about 2) mm. in diameter at base. Leaf blades usually thickish, with veins prominent beneath, usually much more pubescent on the lower than on the upper surface, broadly deltoid in outline, 3-veined from the base and the lateral veins usually almost immediately bifurcate, pedately parted or divided, the mid-lobe and often the primary lateral divisions pinnately few-cleft or even parted, the primary lateral divisions not less than ⅔ as long as the mid-lobe, the latter and often the primary lateral divisions long-cuneate (as if decurrent) at base, all the divisions rounded-truncate to acutish at apex, the larger blades 1–6 cm. long and wider (often considerably wider) than long. Inflorescence racemiform or occasionally subthyrsoid at base, with usually very short internodes, few- (rarely 25-) flowered. Pedicels usually rather stout and much shorter than the calyx, the lower ones sometimes more slender and elongate. Involucel usually wanting. Calyx conspicuously villous, usually densely so, at anthesis 5–10 mm. high, with lanceolate to deltoid-ovate (usually ovate-lanceolate), acuminate lobes 1–2 (rarely 3) times as long as the tube. Petals grenadine, 10–20 mm. long. Column pubescent or glabrescent. Fruit hemispherical or flatter, ½–¾ as high as the calyx. Carpels (pl. 12, *H*) 10–14, very thick, with coriaceous walls, 3–3.5 mm. high and approximately as wide, reniform, deeply and narrowly notched, the dehiscent portion usually horizontal but sometimes ascending, irregularly quadrangular, muticous, with an internal palate-like fold near the base dorsally, the indehiscent portion forming ⅔–⁹⁄₁₀ (usually about ¾) of the carpel, much wider than the dehiscent portion, very coarsely and prominently reticulate, rugose-tuberculate dorsally, usually strongly so; attaching threads usually short. Ovule and seed 1. Seeds sparsely pubescent or glabrous.

Type locality.—"Dry prairies and extensive plains of the Missouri . . . v. s. in Herb. Lewis."

Geographical distribution and habitat.—Great Plains and Great Basin region, southern Manitoba to southern Alberta, southward to western Texas, New Mexico, and northeastern Arizona, eastward to western Iowa, usually at elevations of 3500–8000 feet. Inhabits dry plains and mesas, commonly as a member of the "short grass" association, occasionally in slightly saline soil.

Specimens examined (selected).—MANITOBA. St. Lazare, *Macoun and Herriott* 70870 (CA, F, G, Y).

SASKATCHEWAN. Moosejaw, *Barber* 311 (G). Regina, *Fowler* in 1903 (N).

ALBERTA. Rosedale, *Moodie* 962 (F, G, M, N, S, Y).

NORTH DAKOTA. Burke County: Portal, *Barber* 336 (G). Benson County: Leeds, *Lunnell* in 1899 and 1908 (F, M, N, Y).

South Dakota. Brown County: Sand Lake, *Griffiths* (M). Kingsbury County: Iroquois, *Thornber* in 1894 (C, G, M). Brule County: Chamberlain, *E. J. Palmer* 36082 (G, M, Y). Fall River County: Hot Springs, *Rydberg* 580 (N, Y).

Montana. Cascade County: Great Falls, *Anderson* 64 (C, S). Lewis and Clark County: Helena, *Kelsey* in 1891 (C, F, Y). Yellowstone County: Custer, *Blankinship* 49 (G, M, N). Gallatin County: Bozeman, *Blankinship* 99 (F, M, N), in 1903 (C).

Nebraska. Knox County: Fort Niobrara, *Wilcox* (Y). Sheridan County: Running Water, *Hatcher* in 1886 (C). Thomas County: Thedford, *Rydberg* 1357 (G, N, Y). Adams County: Hastings, *Mathias* 306 (G, M).

Wyoming. Sheridan County: Dayton, *Tweedy* 2265 (Y). Yellowstone National Park: *Nelson* 5997 (C, G, M, N, Y). Albany County: Laramie, *Nelson* 1427 (C, F, G, N, Y).

Kansas. Phillips County: Long Island, *Hatcher* in 1884 (C). Osborne County: Osborne, *Shear* 34 (F, G, N). Logan County: *Hitchcock* 45 (G, M, N, Y). Greeley County: Tribune, *Reed* in 1892 (C, M). Bourbon County: Pawnee Creek, *Wislizenus* 420 (M).

Colorado. Weld County, Crow Creek, *Knowlton* 87 (N, Y). Larimer County: Fort Collins, *Crandall* 116 (G, Y). Rio Blanco County: North Elk Canyon, *Sturgis* in 1902 (C, G). Denver County: Denver, *Jones* 206 (N, Y). Garfield County: Glenwood Springs, *F. Wislizenus* 1033 (M). El Paso County: Manitou, *Clements* 35 (G, M, N, S, Y). Fremont County: Canyon City, *Brandegee* 444 (C). Las Animas County: Trinidad, *Standley* 5993 (N). (?) County: Deer Run, *Baker* 99 (C, G, M, N, Y).

Oklahoma. Woods County: Whitehorse, *Stratton* 389 (M). Beaver County: Knowles, *Stevens* 324 (G, Y). Kingfisher County: Huntsville, *Blankinship* in 1896 (G, M, N).

Texas. Dallam County: Dalhart, *W. W. Jones* 279 (G). Randall County: Canyon City, *E. J. Palmer* 12501 (C, M). Lubbock County: Lubbock, *Demaree* 7506 (G, M, N). Dallas County: Dallas, *Letterman* 65 (F). Midland County: Midland, *Tracy* 7816 (F, G, M, N, Y). Ward County: Monahans, *Clawson* 13906 (N).

New Mexico. Taos County: Taos, *Wooton* in 1910 (N). San Juan County: Farmington, *Standley* 7048 (N). Quay County: Nara Visa, *Fisher* 75 (N). Guadalupe County: Vaughn, *Rose* in 1919 (C). San Miguel County: Las Vegas, *Cockerell* in 1899 (N, Y). Santa Fe County: Santa Fe, *Mulford* 1363 (M, Y). McKinley County: Gallup, *Wooton* in 1904 (N). Lincoln County: Ruidoso Creek, *Wooton* in 1895 (N, Y).

Arizona. Apache County: Carriso Mountain, *Standley* 7483 (N).

This widely distributed species extends farther eastward than any other in North America, reaching longitude 97° in Nebraska and Texas, and longitude 95° in Kansas. It is much more common west of meridian 98°, however, and is perhaps adventive at the more eastern stations.

S. coccinea, in its typical form, differs from all other species of *Eusphaeralcea* in having the flowers nearly always without an involucel, at least by the time of anthesis. Cursory examination of 150 specimens in the United States National Herbarium showed the presence of this structure on only two,[54] and

[54] These were collected at Regina, Saskatchewan (*Fowler* in 1903), and at Monahans, Ward County, Texas (*Clawson* 13906).

in both specimens it was reduced to a single bractlet. Since, however, an involucel was observed on only one of about 80 flowers on one of these plants, it is probably occasionally present on other specimens.

Sometimes the plants lack a well-developed crown and the flowering stems originate, apparently as root shoots, considerably below the surface of the soil. The hairs have the rays united farther above the base than in most species of *Eusphaeralcea*, but they are not scale-like, as in *leptophylla*. They are usually fairly uniform in length and number of rays, but sometimes much longer and fewer-rayed hairs are interspersed among the much more numerous short hairs. Exceptionally tall specimens, with stems as much as 55 cm. long, have been collected in Colorado at Deer Run (*Baker* 99) and at Glenwood Springs (*F. Wislizenus* 1033). A collection at Midland, Texas (*Tracy* 7816), has very small leaves, the blades not exceeding 1.5 cm. in length. At Trinidad, Colorado, a form was collected (*Standley* 5993) in which the dehiscent portion of the carpels is reduced to only about one-tenth of the whole, disappearing entirely in one of the carpels examined.

26*a*. **Sphaeralcea coccinea dissecta** (Nutt.) comb. nov.

Sida dissecta Nutt., *in* Torrey and Gray, Fl. N. Am., 1:235. 1838.

Malvastrum coccineum dissectum A. Gray, Mem. Am. Acad., n. ser., 4:21, 24. 1849.

M. dissectum A. Nelson, Bot. Gaz., 34:24. 1902. Not Harvey, 1860; nor Cockerell, 1900.

Sphaeralcea dissecta Rydberg, Bull. Torrey Club, 40:58. 1913.

Differs from the typical form of *S. coccinea* as follows: Plant usually conspicuously whitish pubescent; stems often more nearly erect and taller; leaf blades more dissected, with narrower divisions.

Type locality.—"Sources of the Platte near the Rocky Mountains." Type (British Museum) collected by Nuttall.

Geographical distribution and habitat.—Wyoming to western Texas and northeastern Arizona, at elevations of 4500–7500 feet. Habitat of the typical form of the species.

Specimens examined (selected).—WYOMING. Sublette County: Cora, *Payson* 4338 (G, M). Carbon County: Fort Steele, *Tweedy* 4571 (Y). Sweetwater County: Granger, *Nelson* 4625 (G, M, N). Point of Rocks, *Nelson* 7148 (G, M, N, Y).

COLORADO. Delta County: Delta, *Tidestrom* 2187 (N). Montrose County: Cimarron, *Baker* 270 (C, G, M, N, Y). Paradox, *Walker* 77 (G, M, N, S, Y). San Miguel County: Norwood Hill, *Walker* 509 (G, N).

UTAH. Salt Lake County: Salt Lake City, *Garrett* 1098 (N), in 1905 (G, Y), *Schuster* in 1929 (C), *Watson* 195 (G, N, Y). Fort Douglas, *Wittich* in 1891 (N). Tooele County: Lakepoint, *Jones* 1931 (F, Y). Utah County: Salem, *Eastwood and Howell* 562 (CA, N). Carbon County: Price, *Stokes* in 1889 (C). Kane County: Kanab, *Jones* 5282 (C, M, N, Y).

TEXAS. Sterling County: *Cory* 543 (N).

NEW MEXICO. Rio Arriba County: Embudo, *Heller* 3514, in part (N). Gallinas River, *Eggleston* 5976 (N). San Miguel County: Las Vegas to Arriba, *Eggleston* 20129 (Y). McKinley County: Agua Azul, *Rothrock* 138 (F, G). Ojo Caliente, *Wooton* 2676 (N). Ramah, *Wooton* in 1906 (N). Lincoln County: Carrizozo, *Plummer* in 1903 (N). Gray, *Skehan* 23 (C, F, G, M, N, Y).

ARIZONA. Coconino(?) County: Little Colorado River, *Ward* in 1901 (N, Y).

This subspecies intergrades completely with the typical form. In its extreme aspect, it is characterized by very narrowly lobed leaves and dense, whitish pubescence; but the writer observed that on opposite sides of a shallow road-cut in New Mexico the plants of *coccinea* approached, respectively, the typical form and the dissected form, the latter growing on the northern bank and therefore receiving more sunlight. Even on the same individual plant (e.g., *Walker* 509, San Miguel County, Colorado) the lower part may simulate typical *coccinea* and the upper part *dissecta*, the change probably having been caused by increasing dryness of the soil as the plant developed. The form *dissecta* seems, therefore, to be in large measure epharmonic, induced by greater aridity. The principal justification for maintaining it as a subspecies is a geographical one. As was pointed out by Nelson (1902, p. 24), *dissecta* is found chiefly from the Rocky Mountains westward, while typical *coccinea* has its center of distribution in the Great Plains region.

A specimen collected at Fort Steele, Wyoming (*Tweedy* 4571), has a woody, horizontal root, nearly 1 cm. in diameter, from which the flowering stems arise at intervals. A similar variation in *leptophylla* has been noted.

26*b*. **Sphaeralcea coccinea elata** (Baker) comb. nov.

Malvastrum coccineum elatum Baker, Jour. Bot. Brit. and For., 29:171. 1891.

M. dissectum Cockerell, Bull. Torrey Club, 27:87, 88. 1900.

M. cockerelli A. Nelson, Bot. Gaz., 34:24, 25. 1902.

M. elatum A. Nelson, Bot. Gaz., 34:25. 1902.

? *M. micranthum* Woot. and Standl., Contr. U. S. Nat. Herb., 16:147. 1913.

Sphaeralcea elata Rydberg, Bull. Torrey Club, 40:58. 1913.

Differs from the typical form of *S. coccinea* as follows: pubescence often shorter and softer; stems more frequently erect or ascending, up to 60 cm. long; leaf blades with mid-lobe relatively more elongate, the lateral divisions only 1/3–2/3 as long as the mid-lobe; inflorescence often with longer internodes; involucel more frequently present, of 1 to 3 bractlets; carpels with the dehiscent portion usually ascending, less quadrangular, often deltoid and acutish, occasionally mucronate or short-cuspidate, relatively larger, the indehiscent portion constituting usually only about 2/3 of the carpel; the attaching threads usually longer; seeds often more pubescent.

Type locality.—Western Texas to El Paso. Type (British Museum ?) collected by C. Wright in October, 1849, No. 41.

Geographical distribution and habitat.—Western Texas to eastern Utah and northeastern Arizona, at elevations of 4000–7000 feet. Habitat similar to that of the typical form of *coccinea*.

Specimens examined.—UTAH. Salt Lake County: Magna, *W. W. Jones* 129 (G). Tooele County: Lakepoint, *Jones* 1015 (F, N). Utah County: Kirkham, *Garrett* 5213 (F). Lehi, *Nelson* 1422 (G). Carbon County: Helper, *Coville and Kearney* 2588 (N). San Juan County: Abajo Mountains, *Rydberg and Garrett* 9644 (N, Y).

TEXAS. Reeves County: East of Kent, *Kearney and Harrison* 19 (N). Toyah Creek, *Tracy and Earle* 96 (F, G, M, N, Y). Culberson County: Kent, *Kearney and Harrison* 20, etc. (N). El Paso(?) County: *Wright* 41, the type collection (G, M, N, Y). Jeff Davis County: Davis Mountains, *Hanson* in 1919 (G). Fort Davis, *E. J. Palmer* 32126 (M). Terrell County: Sanderson, *Kear-*

ney and Harrison 6 (N). Brewster County: Alpine, *Hanson* 54 (N), *E. J. Palmer* 30586 (M), 34421 (Y). Presidio County: Marfa, *Eggleston* 17312 (N, Y).

NEW MEXICO. Rio Arriba County: Embudo, *Heller* 3514, in part (G, N, S, Y). San Juan County: Shiprock, *Standley* 7180 (N). San Miguel County: Pecos, *Standley* 5039 (G, M, N, Y), 5145 (N). McKinley County: Gallup, *Wooton* 2674 (N). Ojo Caliente, *Wooton* 2676 (G, N). Chaves County: Hagerman, *Benke* 5035 (F, G). Lincoln County: White Mountains, *Wooton and Standley* 3594 (N). Catron County: Patterson, *Kearney and Leding* 10 (F, N), 12 (N, Y), *Wooton* in 1900 (N). Grant County: Cliff, *Metcalfe* in 1903 (N). Silver City, *Eastwood* 8394 (CA). Upper Gila, *Greene* in 1880 (F). Eddy County: Carlsbad Cavern, *Bailey* in 1924 (N). Hope, *Campbell* in 1917 (CA). Dona Ana County: San Augustine Ranch, *Wooton* in 1897 (N). Luna County: Florida Mountains, *Mulford* 1074 (M). (?) County: *Fendler* 81 (C, M, Y), *Wright* 881 (G, M, N, Y).

ARIZONA. Navajo County: Holbrook, *Zuck* in 1896 (N).

The type collection of *Malvastrum coccineum elatum* Baker (*Wright* 41), which has no fruit, is an extreme form with large, thin leaves that are very deeply parted and distinctly cuneate at base. None of the other specimens cited here are so different in appearance from typical *coccinea*. In describing the variety, Baker cites also a collection at Moving Fork, Utah (*Fremont* 411), which is the type of *S. pedata* Torrey, a wholly different plant. Subspecies *elata,* in the more frequent presence of an involucel (sometimes of 3 bractlets), in the relatively larger size and more nearly erect position of the dehiscent portion of the carpel, and in the occasional presence of 2 ovules, forms a connecting link between *coccinea* proper and the more typical *Eusphaeralceae,* especially *subhastata pumila* (Woot. and Standl.), which see. There is, however, complete intergradation with typical *coccinea* and many of the specimens here listed are more or less intermediate. The *Malvastrum dissectum* of Cockerell (*M. cockerelli* A. Nelson) is referred here, rather than to subsp. *dissecta,* because it was stated by Cockerell that it "has two ovules in each carpel," a condition that is fairly frequent in subsp. *elata* but not observed by the writer in typical *coccinea* nor in subsp. *dissecta.*

A specimen from Embudo, New Mexico (*Heller* 3514), has 2 developed seeds in some of the carpels, which are occasionally sparsely spinulose near the apex. A form with exceptionally short and close pubescence was collected in the White Mountains, New Mexico (*Wooton and Standley* 3594). A very aberrant specimen from Pecos, San Miguel County, New Mexico (*Standley* 5145), has the leaf blades deeply cleft, rather than parted, and cuneate at base, calyx lobes exceptionally long and attenuate, and carpels with an exceptionally large dehiscent portion. At Patterson, Catron County, New Mexico, the writer found a small form of *coccinea elata* growing with *Atriplex canescens* and a Sporobolus, probably *S. asperifolius,* in the moderately saline soil of an extensive "playa."

Malvastrum micranthum Woot. and Standl., of which the type was collected at Tiznitzin, San Juan County, New Mexico (*Wooton* 2673), may be only a diminutive and aberrant form of *coccinea elata.* It is characterized by

stems only 20 cm. long; leaf blades 1–2 cm. long, with very narrow, coarsely toothed divisions, of which the primary ones are about ⅔ as long as the mid-lobe; flowers small, with petals about 8 mm. long; carpels (somewhat immature) barely 3 mm. high, with a relatively large, erect, acute, mucronate or short-cuspidate, dehiscent portion, forming about ½ of the carpel. The involucel, as in typical *coccinea,* is reduced to 1 or 2 bractlets, or wanting. Another collection, lacking fruit, cited by the authors of *M. micranthum,* was made at Patterson, Catron County, New Mexico (*Wooton* in 1900), but is somewhat coarser in all its parts and is very similar to plants seen growing by the writer at the same locality (*Kearney and Leding* 12) which had typical carpels of subsp. *elata.* The carpels of the type of *M. micranthum* (pl. 12, *I*) seem very different from those of typical *coccinea* (pl. 12, *H*), but various intermediate states are found in subsp. *elata.*

27. **Sphaeralcea endlichii** Ulbrich, *in* Fedde, Rep. Sp. Nov., 12:230, 231. 1913.

S. emoryi Gray, in part, Proc. Am. Acad., 22:293. 1887. Not Torrey, 1849.

Plant perennial, suffrutescent, with a rather small crown and a stout taproot, whitish or yellowish tomentose with rather long, soft hairs, those of the stem 0.3–0.8 mm. long, with 15–25 rays. Stems up to 55 cm. long, up to 5 mm. in diameter at base, decumbent or ascending. Leaf blades firm and sometimes thick, with veins more or less prominent beneath, deltoid-ovate, at base subcuneate to subcordate, at apex very obtuse or slightly retuse and often mucronulate, 3–5-veined from the base, not lobed or very shallowly 3-lobed with rounded lateral lobes, margin very shallowly crenate and sometimes strongly rugose, the larger blades 3–4 cm. long and ¾ to quite as wide. Petioles stout or slender, ¼ as long to longer than the blade. Inflorescence racemiform, becoming elongate, with the flowers finally remote. Pedicels stout, at anthesis shorter than the calyx, attaining a length of about 2 cm. in fruit. Calyx densely soft-pubescent, angulate-nerved, especially in bud, at anthesis 10–18 mm. high, ⅗–¾ as high as the corolla, with deltoid-ovate to oblong-lanceolate, acuminate lobes 1–2 times as long as the tube. Petals grenadine or grenadine-pink, about 20 mm. long. Column glabrous or very sparsely pubescent. Fruit somewhat higher than hemispherical, about ⅔ as high as the calyx. Carpels (pl. 12, *J, K*) about 18, with firm, chartaceous walls, connate at maturity, often strongly so, 4–8 mm. high and ½–⅗ as wide, deeply and usually broadly notched, dehiscent to the base dorsally and nearly so ventrally, with at most a faint trace of reticulation near the base, at apex acutish, mucronate or cuspidate with stout cusps up to 1.5 mm. long, often sparsely spinulose dorsally toward apex and on the cusps; attaching threads long and tough. Ovules 2 or 3. Seeds usually 2, glabrous or sparsely pubescent.

Type locality.—Cañon del Venado, Sierra de la Paila, Coahuila, Mexico, at an elevation of 950 meters. Type (B) collected by R. Endlich, April 2, 1905, No. 847.

Geographical distribution and habitat.—States of Tamaulipas, Coahuila, and Nuevo León, possibly also elsewhere in northern Mexico. Grows among rocks (Endlich).

Specimens examined.—TAMAULIPAS. Jaumave, *Rozynski* 308 (F).

COAHUILA. Saltillo, *Gregg* 249 (G, M), *Palmer* 50 (F, G, M, N), 51 (C, G, M, N), 801 (N), *Safford* 1298 (N), *Wislizenus* 314 (M). Sierra de la Paila, *Endlich* 847, the type collection (B). Sierra de Parras, *Purpus* 1042 (C, F, G, M). Viesca, *Purpus* 539 (C, M, N).

NUEVO LEÓN. Icamale, Sierra Madre, *Safford* 1240 (N).
CHIHUAHUA (?). Alamo de Parras,[55] *Thurber* 845 (G).
STATE (?). Rinconada, *Gregg* 9 (M), in 1847 (G). San Luis Potosí to San Antonio, Texas, *Parry* 82 (G, N). Locality (?), *Gregg* 523 (G, N).

Inclusion of this species in the subgenus *Eusphaeralcea* would be of doubtful propriety if the typical form alone were available. In this, the carpels are dehiscent very nearly to the base and are not reticulate, or but very faintly so, near the base. In other characters, however, the relationship to *Eusphaeralcea* is more apparent. The fugacious involucel of subulate bractlets, capitate stigmas, relatively small, cuspidate carpels, and relatively small seeds exclude *endlichii* from the subgenus *Meliphlea* and the characters of the involucel and carpels exclude it from the subgenus *Phymosia*. The affinity to *Eusphaeralcea* is strengthened, moreover, by the characters of specimens collected near Saltillo, Coahuila (*Palmer* 51, 801). These are atypical in the following particulars: stems and leaves canescent rather than tomentose; leaf blades oblong-ovate and only ½ as wide as long; inflorescence sometimes subthyrsoid below; calyx less conspicuously angulate-ribbed; indehiscent portion constituting about ¼ of the carpel and distinctly although finely and not prominently reticulate near the base. This form should, perhaps, be distinguished as a subspecies. Specimens collected near Icamale, Nuevo León (*Safford* 1240, N), and at Viesca, Coahuila (*Purpus* 539), are very like Endlich's type collection.

Gray (1852, p. 21), in his description of *S. emoryi* Torr., cites, in addition to Emory's type collection, specimens collected in "Mexico at Rinconada and Saltillo, Dr. Gregg." Gregg's specimens are again referred to *emoryi* in Gray's revision of the North American species (1887, p. 293), and in that paper they are stated to be from Chihuahua. The description of the carpels under *emoryi*, as given by Gray in his final publication on the genus (1897, p. 316), evidently is based on one of these Mexican specimens and not on Emory's collection on the lower Gila River, in Arizona. The latter, as represented by the type specimen of *emoryi* in the Torrey Herbarium, has no fruit. A packet in the Gray Herbarium, labeled in Gray's handwriting "Gila, Emory! Hb. Torrey, *S. emoryi*," contains the material on which, in all probability, this description was based. These carpels came, almost certainly, from one of Gregg's specimens, here referred to *endlichii*. They are very different from the carpels of the true *emoryi*, a plant of the Colorado River region in Nevada, Arizona, and California, as will be seen by comparing plate 9, *B*, and plate 10, *B*, with plate 12, *J*, *K*, of the present revision.

[55] May be in Coahuila.

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EXPLANATION OF PLATES

PLATE 1

Details of structure in *Sphaeralcea*, subgenera *Iliamna*, *Phymosia*, and *Meliphlea*. × 2.

A. Involucel of *Iliamna* (*S. rivularis*).

B. Involucel of *Phymosia* (*S. abutiloides*).

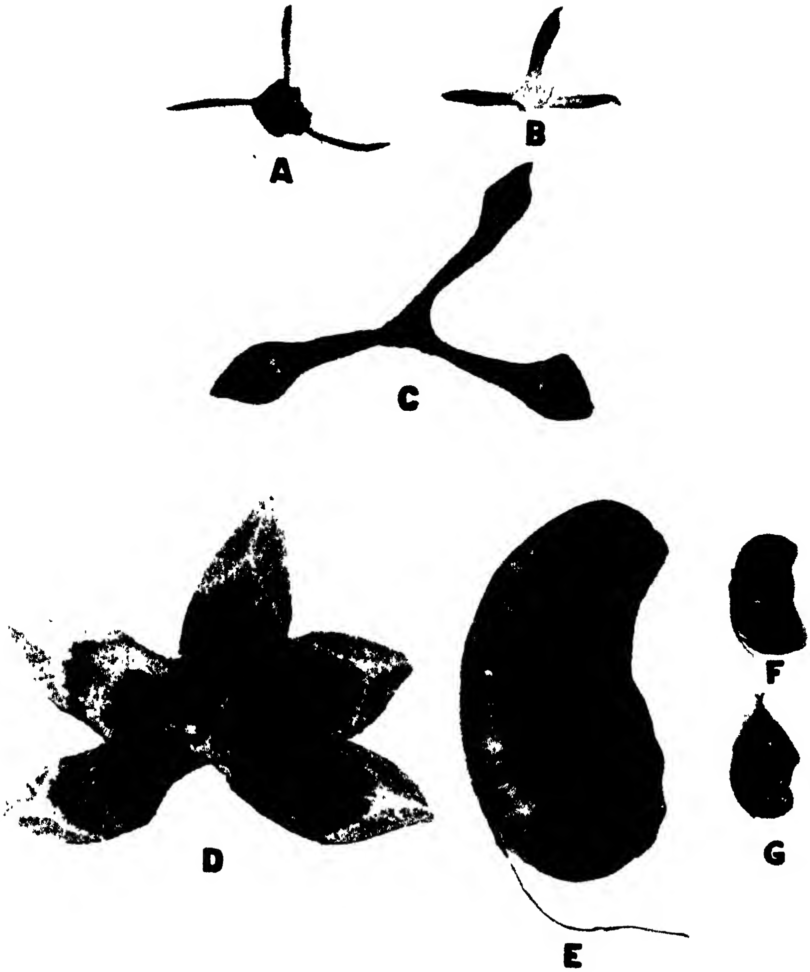
C. Involucel of *Meliphlea* (*S. umbellata*).

D. Calyx of *Meliphlea* (*S. umbellata*) showing the large, segmented, nectariferous disk.

E. Carpel of *Meliphlea* (*S. rosea*).

F. Carpel of *Phymosia* (*S. abutiloides*).

G. Carpel of *Iliamna* (*S. rivularis*).


A
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C
D
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G

PLATE 2

Carpels of Malvastrum. × 8.

A, B. *M. fasciculatum* (*Malacothamnus*).

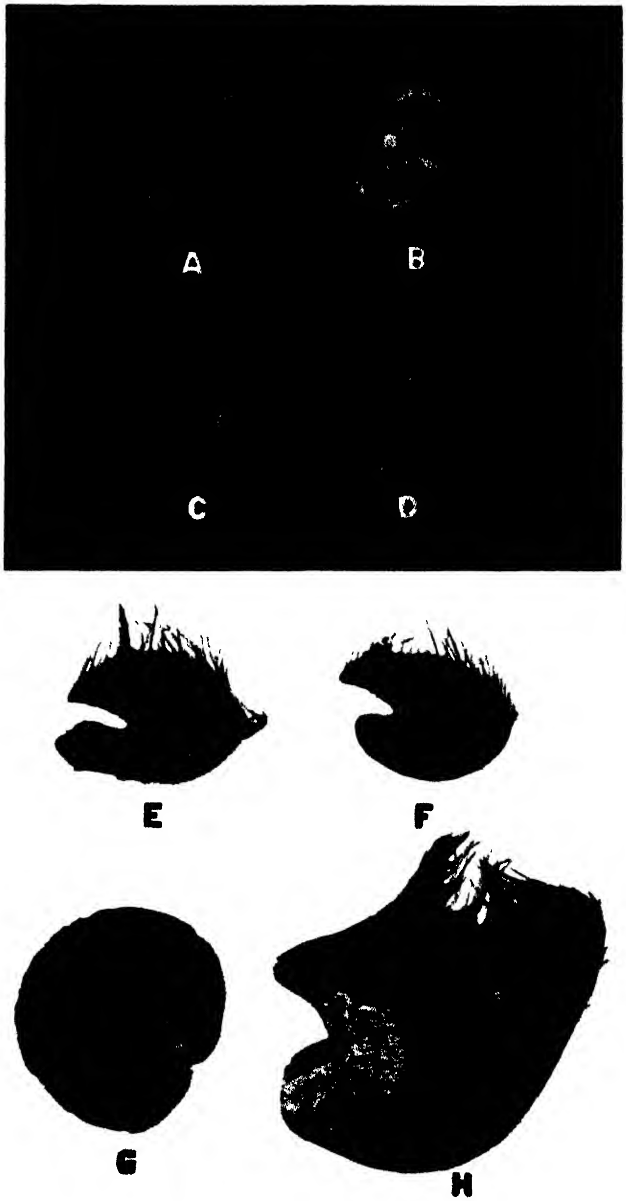
C, D. *M. angustum.*

E. *M. coromandelianum.*

F. *M. spicatum.*

G. *M. rotundifolium* (*Eremalche*).

H. *M. aurantiacum.*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H

PLATE 3

A plant of *Sphaeralcea ambigua* in a sandy "wash" in southern Arizona, showing the open, paniculate inflorescence characteristic of the typical form.

PLATE 4

Plants of *Sphaeralcea* growing at a roadside in southern Arizona.

A. *S. emoryi*, a form with white corollas, showing the narrow, thyrsoid inflorescence that characterizes this species.

B. *S. emoryi* × *S. ambigua* (?), showing a type of inflorescence approximately intermediate between that of the presumable parents. (Compare pl. 3 and pl. 4, *A*).

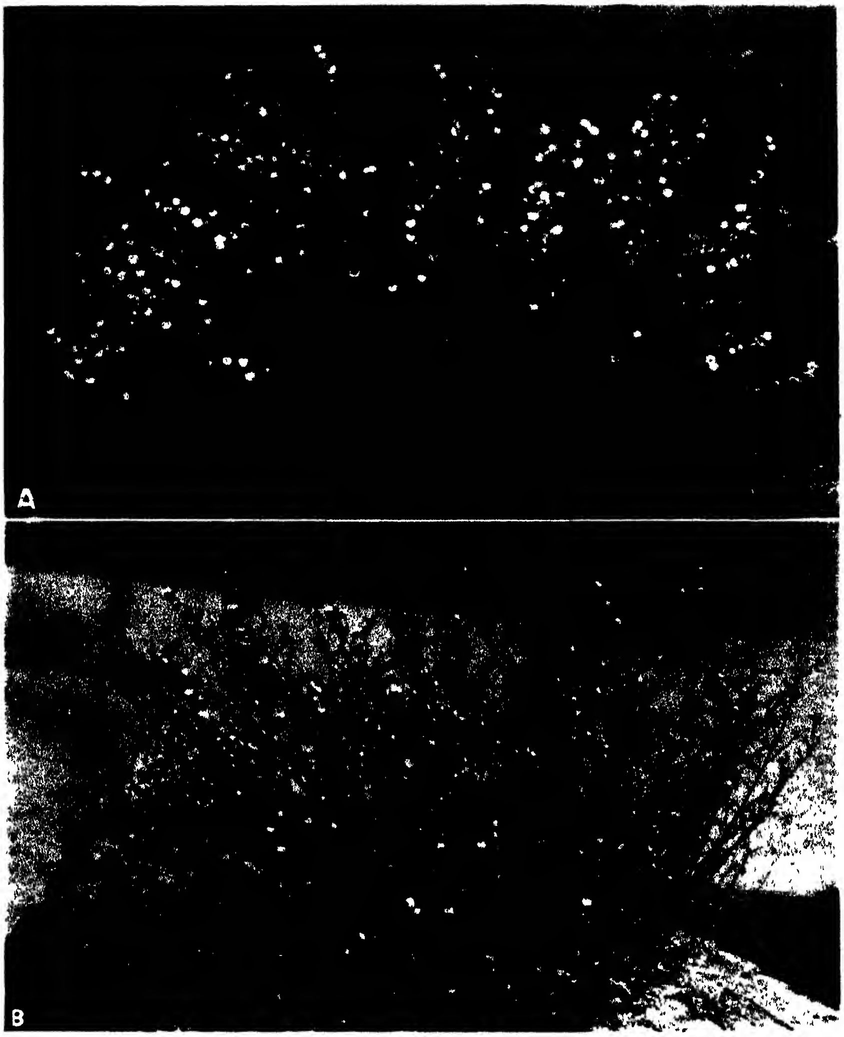


PLATE 5

A–D. Leaves of ***Sphaeralcea rusbyi***, natural size, showing the crenate but otherwise undivided first leaves above the cotyledons (*A*, *B*); and the adult, pedately parted leaves (*C*, *D*).

E. Corolla of ***S. subhastata***, × 3, typical of the subgenus ***Eusphaeralcea*** in the shape of the petals and the ciliation of their claws.

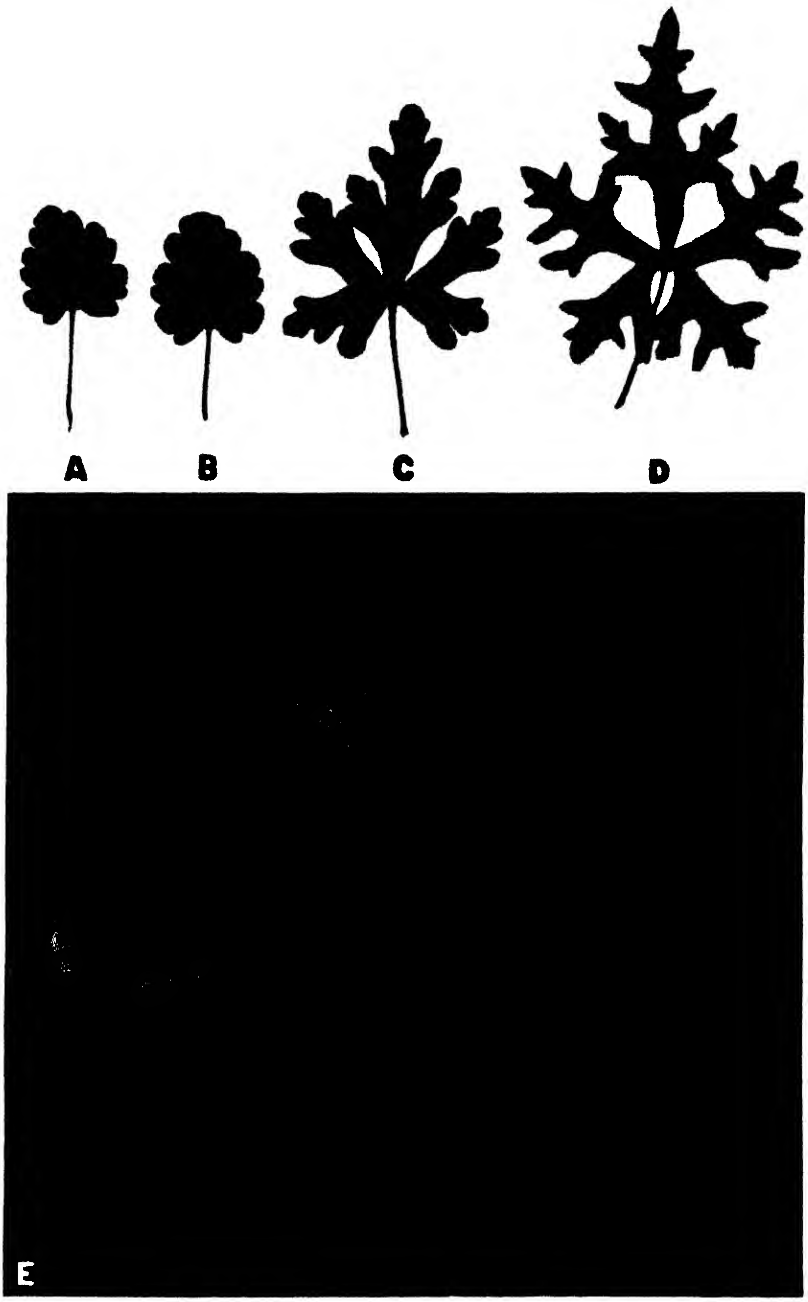

A
B
C
D
E

PLATE 6

Flower parts of typical forms of the subgenus *Eusphaeralcea*. × 7.

A. Outer side of calyx and involucel of *S. fendleri*, showing the 3 separate, subulate bractlets.

B. Staminal column and pistils of *S. fendleri*, showing the pubescence of the lower part of the column and the capitate stigmas.

C. Inner side of calyx of *S. subhastata*, showing the small, segmented, nectariferous disk.

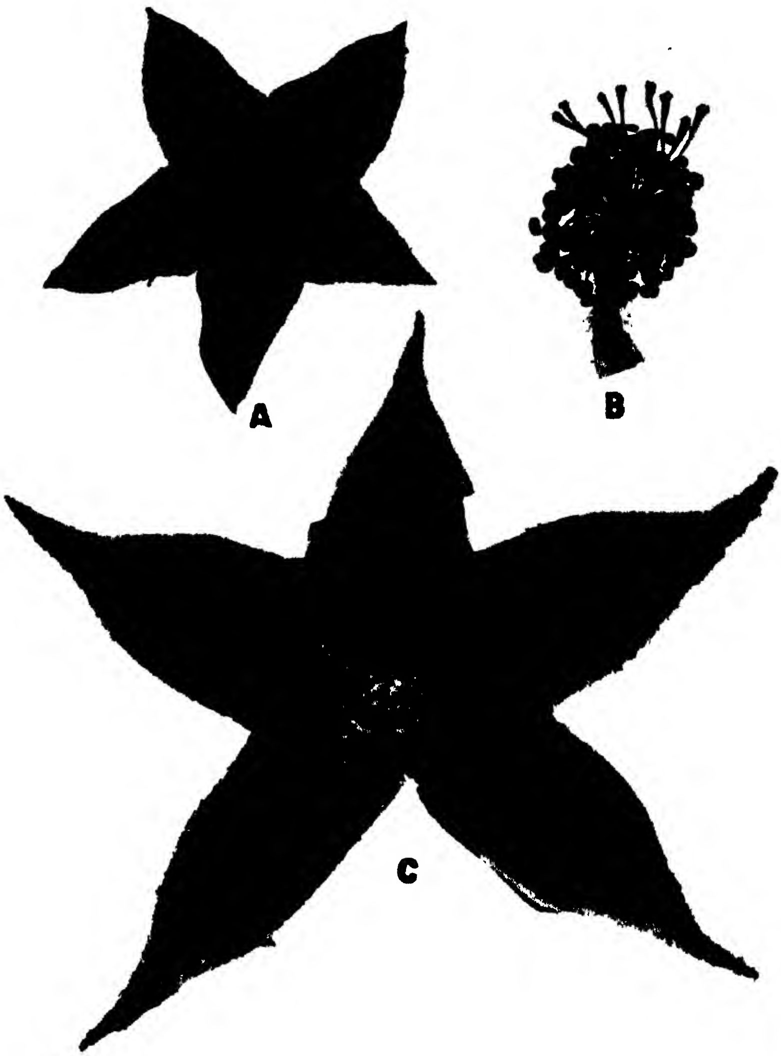

A
B
C

PLATE 7

Fruit and seeds typical of the subgenus *Eusphaeralcea.*

A. Mature fruit of *S. fendleri,* showing the fibrovascular threads by which the carpels are attached to the axis. × 9.

B. Seeds of *S. ambigua,* showing the reniform shape and the pubescence. × 7.


A

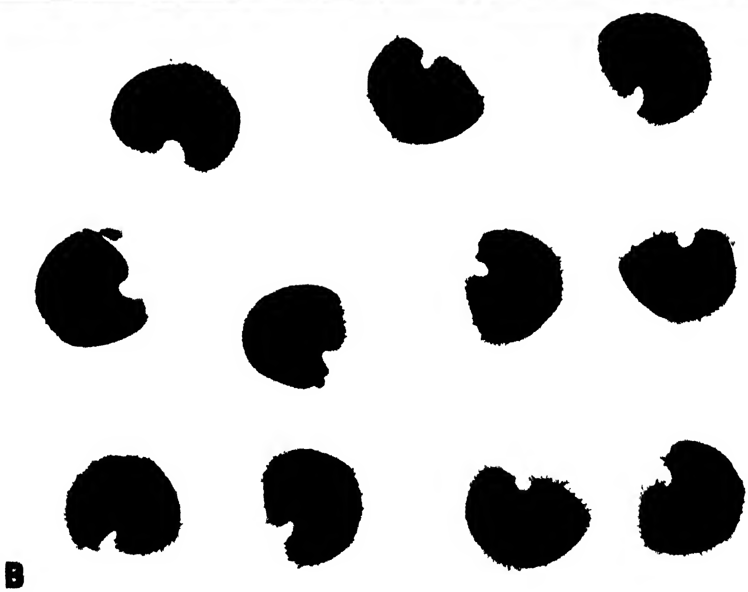

B

PLATE 8

Variations in the shape of the leaf blade in *Sphaeralcea emoryi variabilis*. These leaves were collected within a distance of about one mile, in southern Arizona, each leaf having been taken from a different individual plant. One-third natural size.

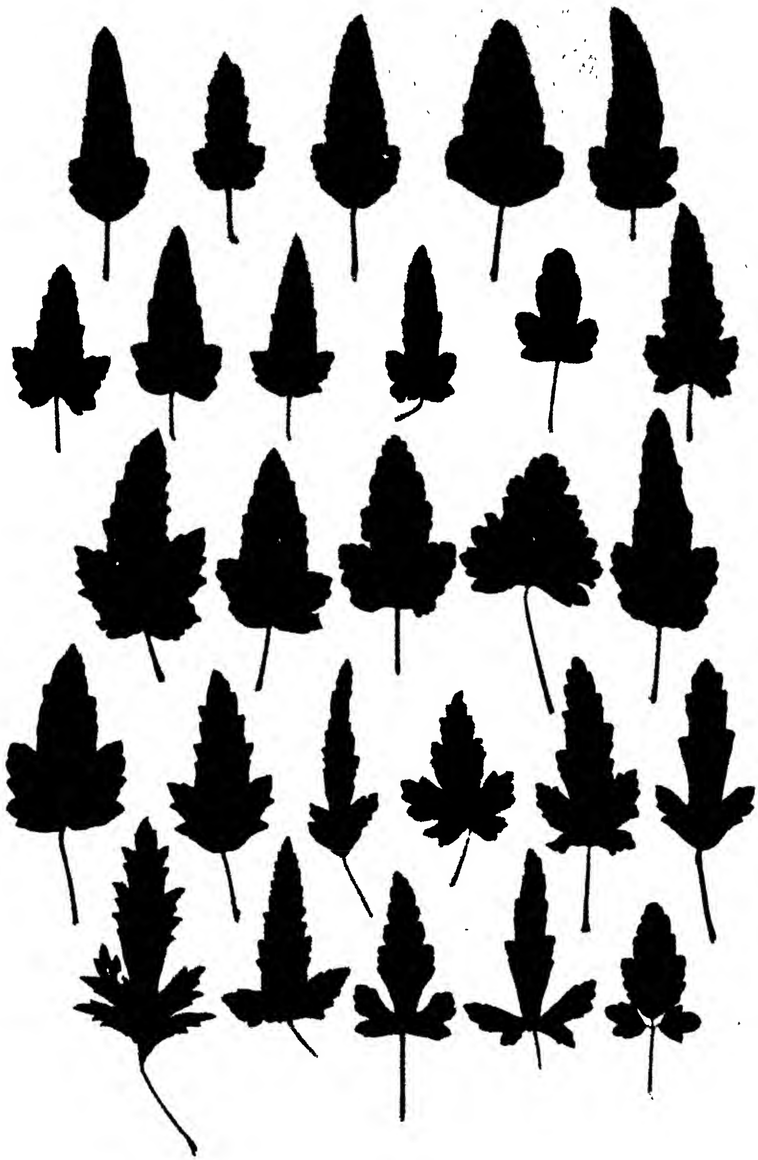


PLATE 9

Carpels of *Sphaeralcea*, subgenus *Eusphaeralcea*, selected as representative of the form in question. × 8.

A. *S. coulteri.*

B. *S. emoryi variabilis.*

C. *S. coulteri* × *S. emoryi variabilis*, F_1(?). The intermediate character of this carpel, as compared with those shown in figures *A* and *B*, and the fact that it is unlike the carpels of any species occurring in the region, point strongly to the conclusion that the plant that bore it was a hybrid.

D. *S. coulteri californica.*

E. *S. pedatifida.*

F. *S. orcuttii.*

G. *S. coulteri margaritae.* (Type collection.)

H. *S. palmeri.*

I. *S. sulphurea.*

J. *S. axillaris violacea.*

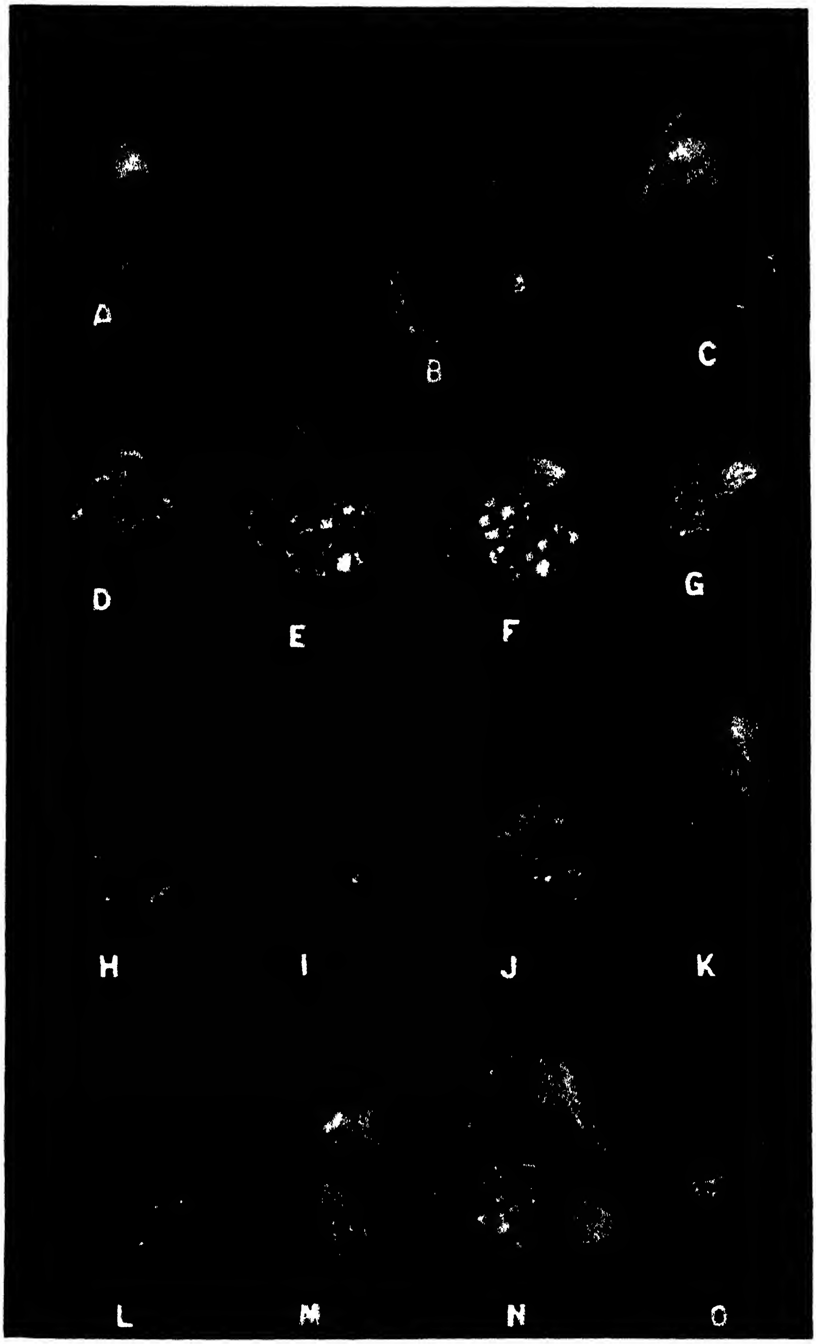
K. *S. axillaris.* (Type collection.)

L. *S. fulva.*

M. *S. ambigua.*

N. *S. ambigua monticola.*

O. *S. ambigua versicolor.*


A
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C
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G
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I
J
K
L
M
N
O

PLATE 10

Carpels of *Sphaeralcea*, subgenus *Eusphaeralcea*, selected as representative of the form in question. × 8.

A. *S. hainesii.*

B. *S. emoryi.*

C. *S. emoryi arida.* (Type.)

D. *S. emoryi* × *S. ambigua?* From a specimen collected by S. B. Parish (No. 610) in the Mojave Desert, California.

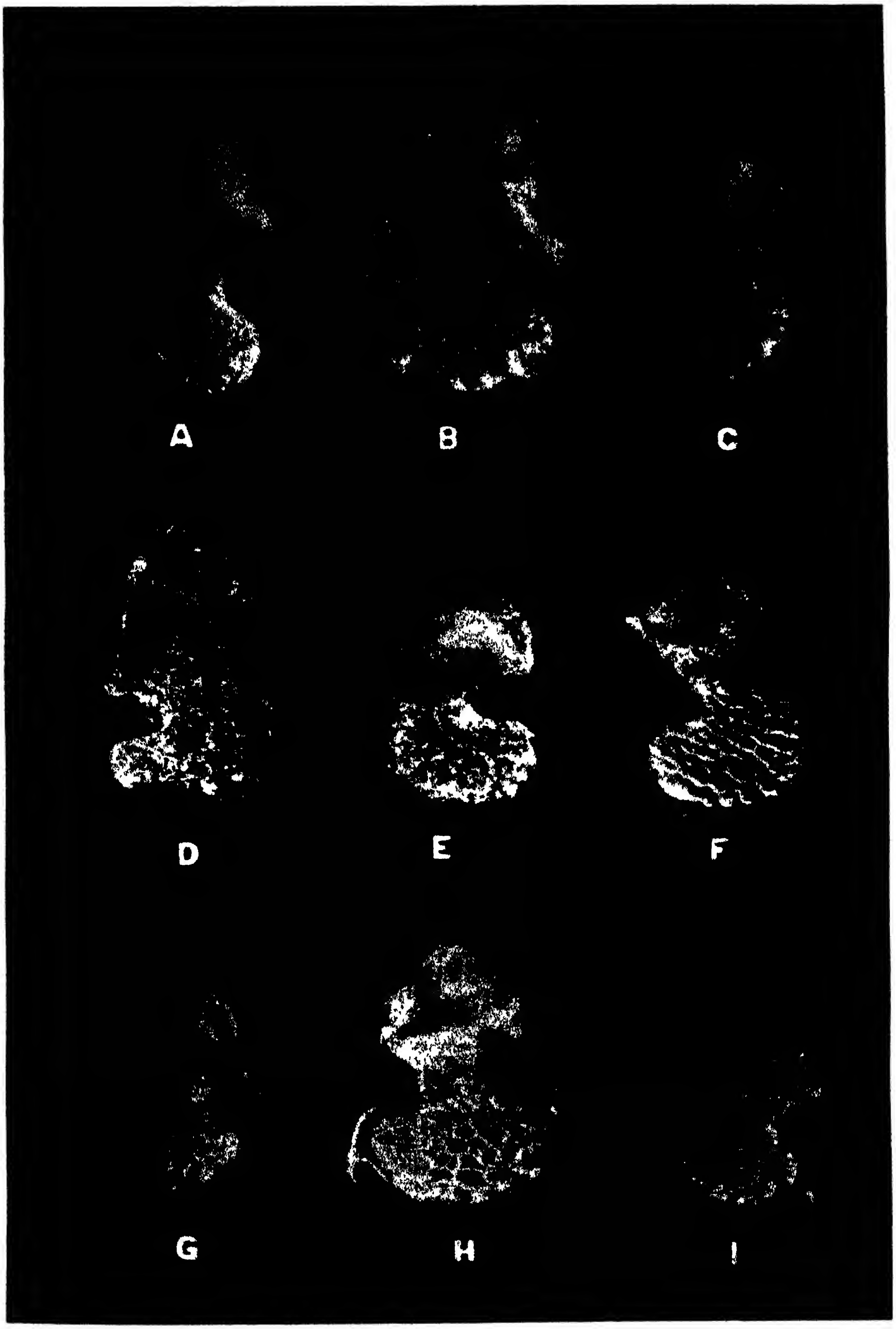
E. *S. lindheimeri.*

F. *S. laxa.*

G. *S. rusbyi.*

H. *S. wrightii.* (Type collection.)

I. *S. incana.*


A
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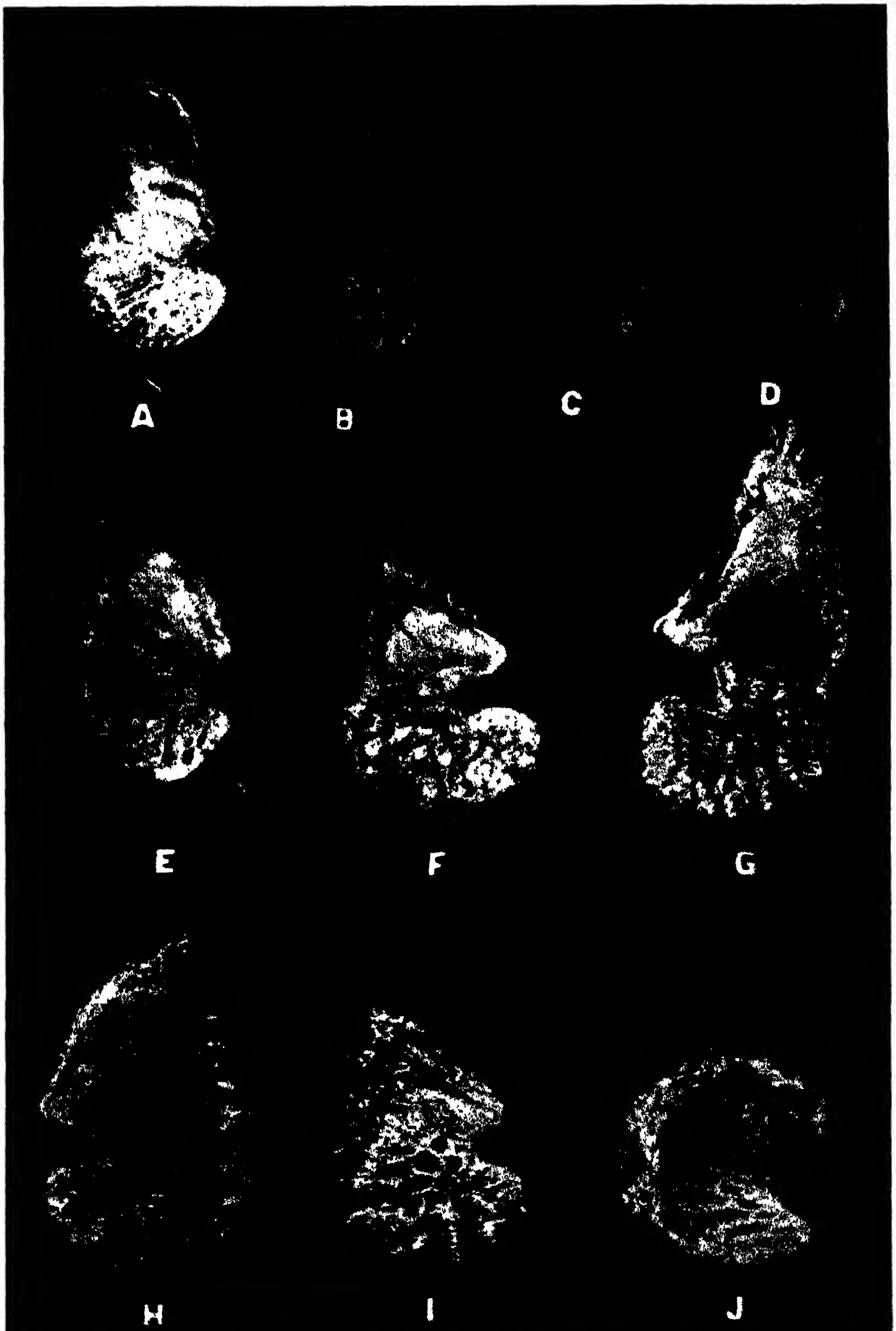
G
H
I

PLATE 11

Carpels of *Sphaeralcea*, subgenus *Eusphaeralcea*, selected as representative of the form in question. × 8

A. *S. fendleri.*
B. *S. fendleri venusta.*
C. *S. angustifolia.*
D. *S. angustifolia cuspidata.*
E. *S. angustifolia lobata.* (Type collection.)
F. *S. hastulata.*
G. *S. subhastata.*
H. *S. subhastata martii.*
I. *S. subhastata pumila.* (Type collection.)
J. *S. caespitosa.*


A
B
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I
J

PLATE 12

Carpels of *Sphaeralcea*, subgenus *Eusphaeralcea*, selected as representative of the form in question. × 8

A. *S. parvifolia.*

B. *S. munroana.*

C. *S. grossulariaefolia.*

D. *S. grossulariaefolia pedata.* (Type collection.)

E. *S. digitata.*

F. *S. digitata tenuipes.* (Type.)

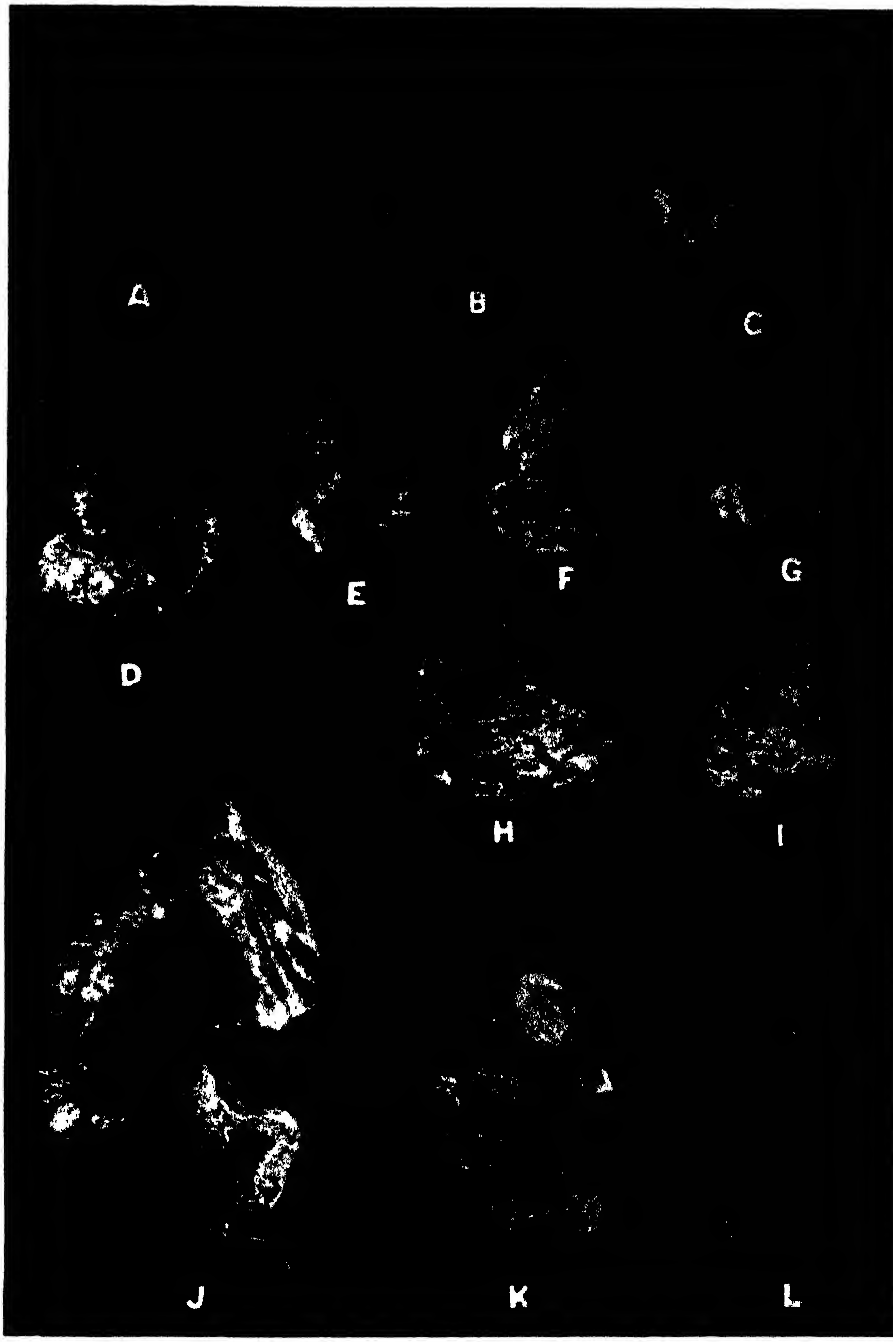
G. *S. leptophylla.*

H. *S. coccinea.*

I. *S. coccinea elata* (?). (Type of *Malvastrum micranthum*).

J, K. *S. endlichii.*

L. *S. miniata cisplatina.*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NOTES ON MICRODICTYON. III

BY

WILLIAM ALBERT SETCHELL

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THE FIRST set of notes on *Microdictyon* was published in 1925 (Univ. Calif. Publ. Bot., 13: 101–108, Sept. 28), when it seemed impossible to proceed farther than preliminary and provisional statements until opportunity should be provided for examination of type and other material preserved in various European herbaria. The number of species recognized was 13, an accession of 5 to the genus. Within the succeeding year, however, the generous response on the part of custodians of such material so clarified the situation as to encourage proceeding with a more inclusive examination of all the species properly belonging to the genus. An extended journey intervening made it necessary to summarize the additional information in "Notes on *Microdictyon*. II" (Univ. Calif. Publ. Bot., 13: 147–154, Aug. 18, 1926). The number of species was increased to 18. The final report on "The Genus *Microdictyon*" was published in 1929 (Univ. Calif. Publ. Bot., 14:453–588, text figs. 1–105, Apr. 19), 18 species still being recognized. Very few additional facts concerning the genus have become known, but these few seem worth communicating.

REDISCOVERY OF THE TYPE SPECIES OF MICRODICTYON

Decaisne founded the genus *Microdictyon* on a plant from the Red Sea, collected at Djedda by Botta. The story of the finding of one, at least, of Decaisne's plants has been related in a previous paper (Setchell, 1929, pp. 480–481). Search had also been made in various herbaria for specimens of *Microdictyon* from the Red Sea, but in vain. It was one of the *desiderata* mentioned to Dr. Cyril Crossland, upon the establishment of the Marine Biological Station of the University of Egypt, at Ghardaqa (near the west entrance to the Gulf of Suez). It was not, however, until May of 1933 that Dr. Crossland was able to rediscover it. Of this collection, a single practically perfect specimen was sent (in formalin), along with other algal material. After close to a century (1836–1933), *Microdictyon Agardhianum* is again collected, and further notes may be added to those derived from a somewhat superficial study of the type, which it was not deemed advisable to soak out and dissect.

The specimen of Crossland is fairly well represented in the figures accompanying these notes which correct the statements of previous papers and confirm those of Decaisne. The color of the specimen was pale green when fresh, but continued preservation in weak formalin solution has faded it to white (or brownish white). It is to be contrasted with the very dark green *M. umbilicatum* (Velley) Zanard and other species of the *Calodictyon*-group

of the *Atrovirescentes*. It is more or less reniform in outline, with a single eccentric point of attachment, a sort of callosity, as Decaisne described it. In "The Genus *Microdictyon*" (1929, p. 484), doubt was expressed concerning the occurrence of such an attachment in *M. Agardhianum*. This was because of the general appearance of the type specimen (dried), which it was not deemed safe to attempt to soak out for a more careful determination of this point. In the Crossland specimens, also, are two or three small blades proliferating from the base. This also supports the statements of Decaisne and corrects the impressions derived from the much folded type specimen. Judging from the Crossland specimen, as well as from the type, *M. Agardhianum* is of more definite growth form, and probably never attains to the size of ordinary, indefinitely expanded specimens of *M. umbilicatum*. The venation of the reticulate blade is fully as distinct as that of the type specimen and sustains the diagnostic character assigned to the species.

The Crossland specimen confirms what was said in "The Genus *Microdictyon*" with respect to microscopical details, to dimensions of the segments of the filaments of the various orders, and to their length-breadth indices. Opposite branching is the rule, and the occasional occurrence of pseudo-flabellate branching is confirmed. The rediscovery of the species has allowed of making more certain the various features of this little known but fundamental species.

Microdictyon umbilicatum (Velley) Zanard

The fronds of *Microdictyon umbilicatum* are probably the largest of all those of the strictly umbilicate species. Velley's plants (Trans. Linn. Soc. Lond., 5: 169, 170, pl. 169, 1800) range up to 13 cm. in their greatest diameter, the individual lobes to about half of that ("between three and four inches," fide Velley, *loc. cit.*, p. 169). Harvey, however (Phyc. Austr., 1: pl. L, 1858), gives an extreme of 12 inches. Velley records the plant as strongly attached and as growing "on the stem of a large Fucus from New South Wales," and with a central base. Harvey (*loc. cit.*) emphasizes the fact that it is found "lying flat on the surface of mud, unattached, or fixed to Algae and Corallines by several points of its lower surface." Specimens received from Mr. A. H. S. Lucas of Roseville, N. S. W., have a spread of lobes of about 15 cm. and appear capable of expanding still farther. They come from various localities about Botany Bay, N. S. W., therefore near the type locality. It seems from these specimens, and possibly from what Harvey says, that *M. umbilicatum* has the habit of lying flat and of forming secondary attachments from which, as sorts of umbilicate bases, other lobes may, as it were, regenerate. The same thing seems true of a considerable number of specimens from Tongatabu (already cited). This "irregular" habit seems very characteristic and distinctive of *M. umbilicatum*.

Microdictyon Okamurai Setchell

The range of this species is extended to the Taumotu or Low Islands, having been collected at Makemo (between long. 145° and 150° W Greenwich, about 3000 miles from Lifue) by the members of the United States Fish Commission

steamer "Albatross" on October 21, 1899, the specimen kindly communicated by Dr. William Randolph Taylor. This extension gives *M. Okamurai* an extremely wide range in the Pacific and eastern Indian oceans.

Microdictyon Setchellianum M. A. Howe

M. A. Howe (Jour. Wash. Acad. Sci., 24:38, 1934) has deemed it necessary to reject the name *M. Velleyanum,* which Decaisne applied (see Setchell, Univ. Calif. Publ. Bot., 14:561, 1929, as limited to the Hawaiian plant, but rejecting the synonym *Conferva umbilicata* Velley), on the ground of technicality of publication, irrespective of the plant to which Decaisne applied it. A rigid application of rule undoubtedly supports Howe in his interpretation of legislation and distrains the pleader from considering any equity such as seems desirable in order to adjust, with proper interpretation, the various binomials, not only the one here concerned, but also others of Decaisne's original account. The species, thus designated, is one which any phycologist may proudly welcome as a namesake, irrespective of a possible stigma of not bowing properly before King "Lex."

Microdictyon Montagnei Harv.

The exact placing of *Microdictyon Montagnei* Harv. is a matter of considerable interest and possibly may ultimately be of fundamental importance in settling various questions which arise, or may arise, in connection with it. The habit has usually been considered as that of a flat, fairly simple (or single) although often expanded membrane. The Harvey specimens from Lifuka in the Haapai Group of the Tonga Archipelago support this idea, as do isolated plants (or plant fragments?) collected at Tahiti and Tongatabu by the writer. The East Indian plant seems to represent at least a variant, as has been mentioned (Setchell, Univ. Calif. Publ. Bot., 14:573, 577–579, 1929). It was, therefore, most gratifying to find the East Indian variant growing in quantity along the southwest and southeast shores of the Island of Bali, in the Netherlands East Indies (reef at Pangapa'an, June 17, and at Sanoer, June 18, 1929). The plants formed extended clumps and compact masses of the rosulate type, considered to be characteristic of the subgenus *Macrodictyon* (see Setchell, *loc. cit.,* 548 and 564, fig. 87), but while some of the lamellae are strictly flat and characteristically *Macrodictyon,* others are spongiose, and, if separated, might readily be judged rather to belong to *Boodlea.* It seems more and more plausible that the *Boodlea paradoxa* Reinbold (Siboga Exped., Mon. LIX, A: 72, 73, f. 13, 1913) is only a condition of *Microdictyon Montagnei* Harv. (see Setchell, Univ. Calif. Publ. Bot., 14:578, 579, 1929). From the various collections now available, it seems fairly clearly indicated that in quiet spots (or whole habitats) the flat expansion of *Microdictyon* is produced, but in boiling surge or even moderately rough water the spongiose *Boodlea* habit is partly or completely assumed.

EXPLANATION OF PLATES

PLATE 13

Microdictyon Agardhianum Decaisne

Topotypes (in Sens. Lat.) from the Red Sea (Ghardaqa—Dr. Cyril Crossland, May, 1933).

1. Entire plant. × nat. size.
2. Entire plant. × 3.5 diam.

(Both seen by transmitted light. Photo, W. C. Matthews.)


1
2

PLATE 14

Microdictyon Agardhianum Decaisne

Same plant as shown on plate 13.

1. Entire plant. × nat. size.
2. Entire plant. × 3.5 diam.

(Both seen by reflected light. Photo, W. C. Matthews.)


1
2

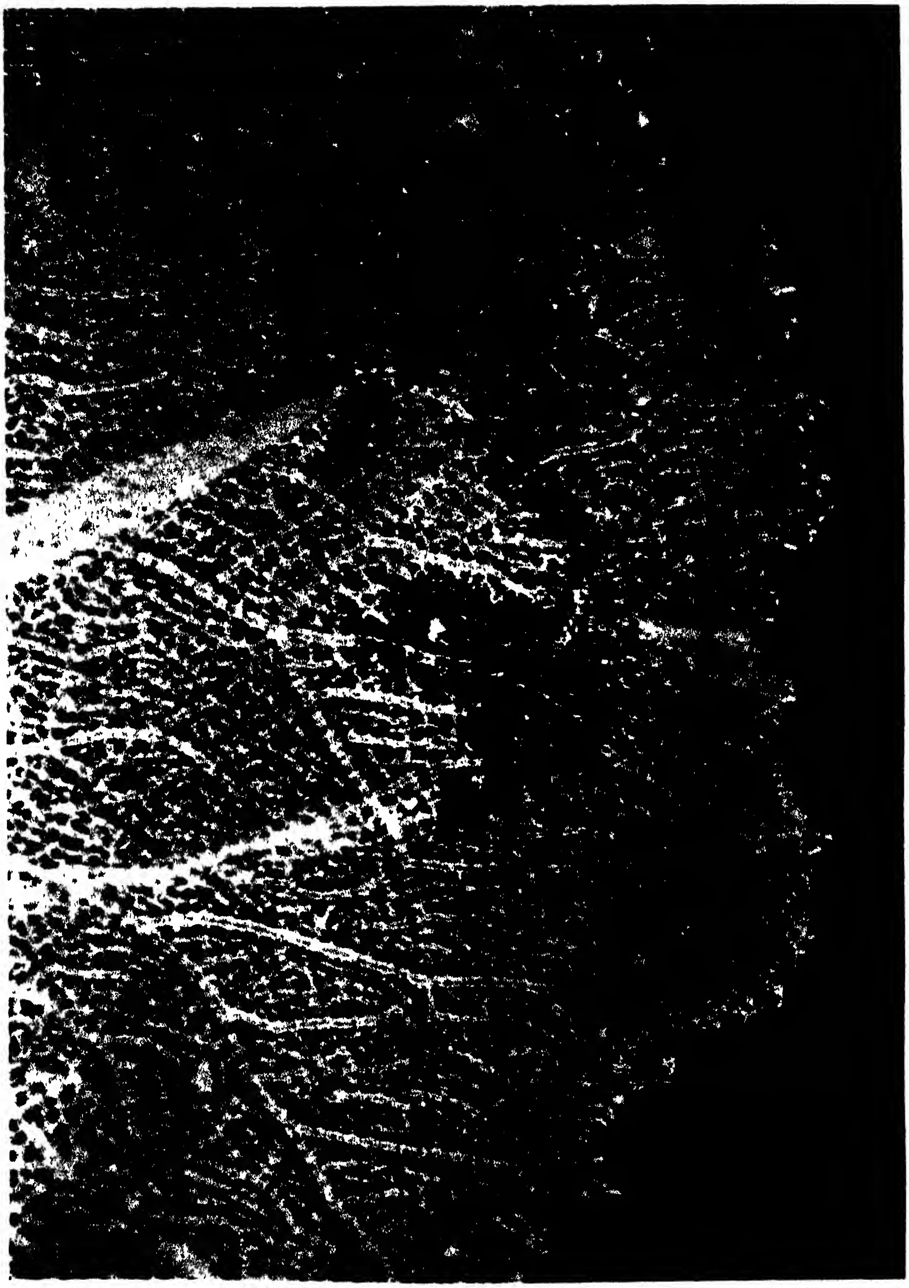
PLATE 15

Microdictyon Agardhianum Decaisne

Same plant as shown on plate 13.

Lobe. × 10 diam.

(Seen by reflected light. Photo, W. C. Matthews.)



ACROBLASTUM VS. POLYPLETHIA

A COMPLEX OF THE BALANOPHORACEAE

BY

WILLIAM ALBERT SETCHELL

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WILLIAM GRIFFITH, in a posthumous paper in 1851 (Trans. Linn. Soc. London, 20:94, pl. 7), proposed, as a new species, *Balanophora* (*Polyplethia*) *polyandra,* to receive plants from the Khasia Hills ("Colles Khasiyani") in Assam. The name *Polyplethia* is evidently intended to indicate a section or a subgenus, characterized by the plurilocular androecium of *B. polyandra.* J. D. Hooker (Trans. Linn. Soc. London, 22:47, 1859) does not regard the species as showing "any point of importance except the anthers in which it differs from *B. dioica,*" but the pistillate specimens, says Hooker, presented difficulties in being distinguished from those of *B dioica.* William Fawcett (Trans. Linn. Soc. London, ser. 2, Bot., 2(12):237, 238, Oct., 1886) seems to have been the first to follow up the suggestion of Griffith and to segregate the species content of *Balanophora* into groups, not distinguished by any names, in accordance with the structure of the androecium. In 1889, Engler elaborated the family Balanophoraceae for "Die Natürlichen Pflanzenfamilien," 3(1):243–263. The family, as was customary, was extensive and included 6 subdivisions, most of which Van Tieghem, with later and seeming perspicacity, has ranged not only in families different from one another, but also in different orders, according to their resemblance to the "Santalineae," on the one hand, or to the "Loranthineae," on the other, their general resemblance counting chiefly in their being pale root parasites. Engler, however (p. 250), ranges under his division "Balanophoroideae" the Balanophoreae and the Langsdorffieae, because of the distinctive character of their rhizomes with respect to possessing the resin-like substance, balanophorin. Engler further separates the species of his extended genus *Balanophora* into groups, still unnamed, based chiefly on the different types of androecia, in accordance with the suggestions of Fawcett. Finally, in the last (4th) "Nachträge zu II–IV" of "Die Pflanzenfamilien" (ergänz. Bd. 3, p. 76), Pilger and Krause review Van Tieghem's arrangement of 1907 without expressing either approval or disapproval.

In 1907, Ph. Van Tieghem (Ann. Sci. Nat., Bot., ser. 9, 6:134–213) discussed in detail the "alliance des Balanophorales," carrying into logical effect the results of certain studies of flower structure of the various members of the alliances (orders?) grouped about *Loranthus,* made in 1896 (Bull. Soc. Bot. de France, 43:295–310), and climaxing, as it were, a long series of studies on his division of the "Inovulées." In connection with his attempt to expound a classification of plants based on "egg" variation and behavior (see Van Tieg-

hem, Ann. Sci. Nat., Bot., ser. 8, 14: 213–390, 1901), Van Tieghem segregates the order of the "Loranthineae," as he designates the larger assemblage, which are both innovulate and innucellate, into 4 alliances: Elytranthales and Loranthales, characterized by bisexual flowers with double perianth, and Viscales and Balanophorales with unisexual flowers and simple perianth. The Viscales have bicarpellary flowers and are chlorophyllose, and the Balanophorales have monocarpellary flowers and are devoid of chlorophyll. The Balanophorales are considered to include only two families; that is, only two of the subgroups of the Balanophoraceae as visualized by Engler in 1889, viz., Langsdorffiaceae (with 2 genera and 4 species, both tropical American and African, with pistillate flowers without appendages, with concrescent perianths and with straight acrogamous prothalli), and Balanophoraceae (with 5 genera and many species, all Old World, with appendages to the pistillate flowers, without perianth, and with prothalli curved into a "U" and basigamous). All the plants included by Van Tieghem among the Balanophorales lack starch (or starch-like materials) but do secrete (or excrete?) a waxy, inflammable material, the "balanophorin." The other subgroups, commonly placed (as by Engler and Prantl in 1889) under Balanophoraceae, such as Cynomoreum, Lophophyte, Sarcophyte, Helosis, differing not only in their metabolic products and the ovulation and nucellation but also in the details of floral structure, are grouped variously by Van Tieghem (1901: 320, 325, etc.).

Van Tieghem, besides limiting his family Balanophoraceae to members of the genus *Balanophora* (as understood in its most inclusive sense), undertook to segregate from the genus *Balanophora* 4 additional genera: *Bivolva, Balania, Balaniella,* and *Polyplethia,* thus following the suggestions of Griffith, Fawcett, and Engler. The first two have been discussed by the writer elsewhere (Setchell, Hong Kong Naturalist, Suppl. 1: 2–14, pl. 1–8, Oct., 1932), where *Balania* V. T. and *Bivolva* V. T. were united, but a new genus, *Balaneikon,* was segregated. Some species, referred under *Balanophora*, are awaiting reference to *Balaniella* V. T., but *Polyplethia* V. T. and its content is our more immediate consideration.

The genera of Van Tieghem, disregarding the variance of splitting of the cataphyll-like scales along the stem (used by Van Tieghem for segregating the family into two tribes, under the seeming misconception that the scales of *Bivolva* represent an entity, a "volva," entirely different from the scales of the plants of the rest of the Balanophoraceae), are based, as seems reasonable, on the variation of the androecium: for example, *Balanophora* (the typical species) has the actinomorphic male flower usually 4-merous, with 4-6 anther-sack pairs, each pair hippocrepiform; *Balaniella,* with the male flowers always 4-merous but with the anther-sack pairs indeterminate, but in larger number than 4, and vertical to the horizontal plane of the flower; *Balania* V. T. (including *Bivolva* V. T.) with its actinomorphic flower, almost always 3-merous, with the anther-sack pairs, episepalous, the pairs more or less concrescent with one another end to end and transverse to form a triangular structure, the male flowers with elongating pedicel enclosed until late anthesis, within deep alveo-

lae formed by the concrescent bracts; *Balaneikon* Setchell, similar to *Balania* but without concrescent bracts; but *Polyplethia* V. T. (subgenus (?) of Griffith) has the zygomorphic male flower, flattened transversely, showing the elongated androecium covered with several to many anther-sacks in two (or irregularly more) almost horizontal series, dovetailing into one another and resultantly irregularly hexagonal.

The simple type of androecium in Balanophorales, as Van Tieghem saw it, may be represented by that of *Langsdorffia* of the Langsdorffiaceae, where the three extrorse stamens are distinct, divergent, and opposite the divisions of the simple perianth. The analogous form in Balanophoraceae seems to be represented by the male flowers of *Balania* (including *Bivolva*) and of *Balaneikon*. Both these genera seem to have simple actinomorphic male flowers, but with the filaments (?) coalescent back to back into a longer or shorter column, bearing the 3 anthers, also opposite the divisions of the single perianth, and practically episepalous. A departure is seen in the male flowers of *Balanophora*, where the 4–5 stamens are concrescent into a conspicuous column with the 4–5 hippocrepiform anthers on its vertical faces and opposite the divisions of the actinomorphic perianth. From these more simple types, *Balaniella* and *Polyplethia* species show lateral floral compression and consequent zygomorphy of the male flower with retention of the coalescence of the extrorse staminal elements into a column, and deduplication of anther-sacks on its surfaces. In *Balaniella* the staminal column is prominent and bears an indeterminate number of straight, parallel anther-sacks on its outer face. In Van Tieghem's (and Griffith's) *Polyplethia*, the staminal column is elongated (transversely in the flower), low, rounded above, and bears a varying number of short, more or less hexagonal anther-sacks in a more or less reticulate fashion on its upper surface. It has, seemingly, the most complicated, or at least the most divergent, androecial structure within the family, if reference to the condition in *Langsdorffia* as more primitive is relevant.

The pistillate plants of the entire series of the genera and species of Balanophoraceae (as limited by Van Tieghem) show fairly uniform morphology of the female reproductive organs (naked, simple pistils) and their accompanying club-shaped "bractlets" (or "spadicels"). In fact, it is impossible to determine generic position from purely pistillate plants of the dioecious species. Specific segregation may, however, be made clear by minor variations, particularly of the spadicels.

Van Tieghem's views concerning limitation of the terms Balanophorales and Balanophoraceae to balanophorin-containing parasites, and the generic segregation of the Balanophoraceae, at least into *Balanophora, Balania* (including *Bivolva*), *Balaniella,* and *Polyplethia* seem logical and proper of adoption; possibly *Balaneikon* Setchell may be added. If this may be granted, the designation and content of *Polyplethia* (Griffith) V. T. comes naturally before us for discussion.

Polyplethia was proposed by Griffith in 1844 (not effectively published, however, until 1851 in Trans. Linn. Soc. London, 20: 94), but even then only

as a parenthetic interpolation in the designation for his *Balanophora* (*Polyplethia*) *polyandra*. Hooker, in 1855 (published in 1859), while considering Griffith's species as an outlier of *Balanophora,* paid no attention to Griffith's subgeneric (?) implication. The effective publication of *Polyplethia,* as a genus, was made by Van Tieghem as late as 1907 (Ann. Sci. Nat., Bot., ser. 9, 6: 193), although as early as 1896 he had indicated the erection of the section *Polyplethia* into a genus (Bull. Soc. Bot. de France, 43: 298), but no Latin, nor in fact any distinctive, diagnosis was appended. The genus, however, was segregated and diagnosed much earlier by Solander, who found among the plants of Cook's first voyage (collected sometime between April 13 and July 12, 1769) a root parasite to which he gave the name *Acroblastum pallens* Solander in his manuscript (Primitiae Florae Insularum Oceani Pacifici, pp. 310, 311), accompanied by full descriptions both of the genus and of the "species." Solander in fact describes the 12–15 locular androecium as characteristic of his genus. These generic and specific designations together with their diagnoses were not published, however, until 1866, when Seemann transcribed them in the "Flora Vitiensis" (p. 100), thus constituting effective publication. Attention was directed to these facts in 1926 (Setchell, Univ. Calif. Publ. Bot., 12: 173–175, pls. 29, 30), and it was suggested that should Van Tieghem's idea of segregation be adopted, the generic name *Acroblastum* antedated the Van Tieghem designation. The Tahitian species, *Acroblastum pallens* Sol., thus becomes the type of the genus and the other species of the *Polyplethia*-section must be referred to *Acroblastum* with it.

There is, however, an Algal genus *Acroblaste* of Reinsch (Bot. Zeit., 37: 360, pl. 3, 1879), but since it differs from *Acroblastum* Sol. in the last two letters, this generic name does not prevent the adoption of Solander's name.

Van Tieghem recognized 2 species under his "*Polyplethia*" and considered it to be localized in the eastern Himalayas and in extreme western China. If, as seems fairly certain, *Balanophora Hildebrandtii* Reichenb. f. from the Comoro Islands (north of Madagascar) does not belong to this genus, *Acroblastum pallens* Sol. from Tahiti and *B. Wilderi* (Setchell) Setchell from Rarotonga do extend the range of the genus from Assam and the eastern Himalayas to the eastern parts of Polynesia.

Synopsis of Acroblastum

I. Rhizomes with conspicuous lenticels (as segregated and stellate pustules)

I.A. Inflorescences bisexual (monoecious)

1. *A. pallens* Solander

Acroblastum pallens Solander, Primitiae Florae Insularum Oceani Pacifici, 310, 311 (ined.); in Seemann, Fl. Vit., 99, 1866; S. Parkinson, Drawings of Tahiti Plants, pl. 91 (ined.). *Balanophora pallens* Setchell, Univ. Calif. Publ. Bot., 12: 173–175, pls. 29, 30, 1926. *Balanophora Hildebrandtii* Fawcett, Trans. Linn. Soc. London, ser. 2, 2 (pt. 12): 233, 234, 1886 (Tahitian plant only).

Scapes low and stout (up to 12 cm. high, 0.5–1 cm. thick), from a compli-

cated tuberoid rhizome (10–15 cm. long, 1–3 cm. thick), the pistillate flowers forming an elongated ellipsoidal capitulum (3–4 cm. high, 1.5–2 cm. thick), the staminate flowers scattered below, with small, usually almost aborted bracts; color light yellowish-white; androecium somewhat elongated, convex, with about 20 more or less hexagonal loculi, in 2–3 rows; pistils with long slender pedicels and styles with outer cells in almost straight rows, borne only on the floral axis; spadicels about 1 mm. high, pedicellate, slender stalked, pyriform, gradually enlarging to the broad (about 0.3 mm.), slightly rounded summit whose outer cells are minutely verruculate.

On roots of Ficus sp. and of *Hibiscus tiliaceus,* Tahiti.

2. *A. Wilderi* (Setchell) comb. nov.

Balanophora Wilderi Setchell, *in* Wilder (Gerritt P.), B. P. Bishop Mus., Bull. 86: 47, pl. 4, 1931 (*sine diagn. Latina*).

Diagnosis: Acroblastum—rhizomate e radice hostis gracili angusto emergente, basi late aut anguste cuneate-applanato, supero dilatato, et dichotome ramoso, ultime usque 4–5 cm. alto et 5–6 cm. lato, plus-minusve grosse cristato, ramis ultimis 1–1.5 cm. latis et 1–2 cm. longis, superficie minute pustulato, pustulis majoribus in gregibus stellatis collectis et regulariter dispersis; inflorescentiis e apicibus ramorum ultimorum, erumpentibus, 5–7 cm. altis, infero 0.5 cm. diam. et cylindricis, supero spadiformibus, tumidis, usque ad 1 cm. diam., monoicis; floribus fertilibus foemineis infero, supero floribus masculis; axi sterili, folioso, foliis membranaceis arcte imbricatis, 6–9, oblongo-lanceolatis, exterius convexis, apice obtusis, rotundis, et cucullatis; floribus foemineis in parte infero spadicis archegonii-formibus, ventribus tumidis et pedicellatis, collis gracilibus, cellulis in 4 seriebus longitudinalibus tortisque, aut lateraliter in spadicellarum late orbicularium pedicellis insertis aut liberis; parietibus cellularum superficiaribus spadicellarum levibus; floribus masculis, in parte superiore spadicis, arcte congestis inter papillas verruciformes solidas tumidasque, in altitudine latitudinesque alabastros florum masculorum prope aequantes, perianthiis 3–5 inaequaliter fissis, lobis crassis, ovato-cucullatis, interne per pressuram synandriorum sculptis; synandriis in floribus quibusque singulis, horizontaliter compressis, brevi pedicellatis, superne convexis, thecis polliniferis 10–13, lateraliter pauci–(2–3) seriatis, ab supero polygonis.

In radicibus Fici sp. parasitica; in montibus Rarotongensibus; Gerrit P. Wilder et H. E. et S. T. Parks, in Junio vegetativis, in Julio florescentibus.

Ab speciebus Balanophorearum aliis omnibus, per positione florarum masculorum ampliter diversa.

A slender monoecious species with the staminate flowers above, differing in this character from all others of the genus. It is much more slender than *Acroblastum pallens* Solander of Tahiti.

Description.—Rhizome slender at emergence from the root of the host, soon increasing in size, cuneate applanate, becoming also dilated and branching dichotomously, occasionally cristate, forming a flattened mass 4–5 cm. high and 5–6 cm. broad, the ultimate branches 1–1.5 cm. thick and 1–2 cm. long, superficially pustulate with occasional stellate clusters of pustules, regularly spaced; fertile stems emerging from the branches of the rhizome, 5–7 cm. high, 0.5 cm. thick, cylindrical below, swollen above into a spadix about 1 cm.

in diameter, monoecious, with pistillate flowers below and staminate flowers above; pistillate flowers archegonium-like with swollen but short pedicelled basal portion and slender neck of 4 twisted series of cells, either free or attached laterally to the spadicels; spadicels orbicular, broadly pedicellate with the outer walls of the cells of the upper surface smooth; staminate flowers occupying the half (or more) of the spadix, crowded among the papilliform, swollen, solid bracts of equal height and diameter with the staminate flower buds; perianth unequally 3–5 divided, with thick ovate-cucullate lobes, internally sculptured through pressure of the synandria; synandria single in each flower, horizontally compressed, short stalked, convex above, and bearing 10–13 pauciseriate polygonal thecae.

Scapes moderately tall and slender, upright, from a broad branched rhizome; color brownish; inflorescences bisexual, the staminate above the pistillate, continuing the compact spadix; male flowers crowded at apex of spadix, distinctly pedicellate, with conspicuous, persistent bracts; androecium 8–15-loculate; pistils with spirally twisted styles, borne chiefly on the spadicels, but also on the spadix; spadicels stout, with a broad pedicel abruptly expanding into a more or less globular head, outer cell walls all smooth.

Parasitic on roots of *Ficus*. Rarotonga. Gerrit P. Wilder and H. E. and Susan T. Parks. (V. S.)

3. *A. Fawcettii* (Elmer) comb. nov.

Balanophora Fawcettii Elmer, Leafl. Philip. Bot., 5: 1659, 1660, 1913.

Scapes slender (from a few cm. to 1 dm. high, more or less than 5 mm. thick), from a lobulate rhizome; color pale yellow; staminate flowers scattered below the ovoid elliptical or oblongish pistillate spadix; staminate flowers "sessile"; androecium with about 10 hexagonal loculi; pistils short pedicellate; spadicels pedicellate. Luzon, Philippine Islands. (N. V.)

I. B. Inflorescences unisexual (dioecious)

4. *A. hexamerum* (V. T.) comb. nov.

Polyplethia hexamera Van Tieghem, Ann. Sci. Nat., Bot., ser. 9, 6: 194, 195, 1907.

Scapes long and slender (20–25 cm. high, 3–4–5 mm. thick, the pistillate scapes slightly the thicker), from a dichotomously branched and coralloid rhizome; color dull yellow; staminate flowers covering the upper third (approx.) of the scape; arranged in whorls with intervening spaces, bracts very short and almost aborted; androecium with a very large number of crowded loculi; female flowers crowded in a cylindroconic capitulum, 1.4–1.3 the length of the leafy scape. China; leg. M. Farges. (N. V.)

5. *A. parvius* (Hayata) Setchell et Yamamoto comb. nov.

Balanophora parvior Hayata, Jour. Coll. Sci. Imp. Univ. Tokyo, 25: 192, 193, pl. 34, 1908, Yamamoto, Ann. Rept. Taihoku Bot. Gard., 1: 97, 1931. Scapes slender (pistillate about 7 cm. high, 3–5 mm. thick, staminate up to 14 cm. high, 3–5 mm. thick), from short, somewhat lobate-branched rhizomes; rhizomes pale lemon in color, the stalks of the inflorescences pale amber to orange, scale leaves transparent brown to reddish, androecial flowers lemon

color, gynoecial flowers pale reddish-brown; staminate flowers scattered regularly, distant from one another, in distant whorls, occupying somewhat more than upper half of scape; androecium with about 20 loculi; pistillate flowers densely massed in an oblong-cylindroconic spadix (up to 3.5 cm. long and 5 mm. thick), shortly stipitate, borne on the pedicels of the spadicels; spadicels long pedicellate, above clavate capitate with rounded apex. Formosa. (V. V. Yamamoto.)

II. Rhizomes destitute of lenticels (no segregated and stellate pustules)

II. A. Inflorescences bisexual (monoecious)

6. *A. subglobosum* (Elmer) comb. nov.

Balanophora subglobosa Elmer, Leafl. Philip. Bot., 5:1660, 1661, 1913.

Scapes low and slender (3 cm. long, 3 mm. thick), from densely fleshy clumps of spreading rhizomes; color yellowish-white; staminate flowers below, scattered; bracts (?); androecium yellow, with about 6 hexagonal loculi; pistillate flowers densely crowded on a terminal globose head, stipitate, fusiform, style brownish; spadicels with an expanded or disk-like blackish-brown pitted top; lower parts light brown and stipitate. Palo, Leyte, Philippine Islands. (N. V.)

7. *A. insulare* (Ridley) comb. nov.

Balanophora insularis Ridley, Jour. Roy. Asiat. Soc. (Straits Branch), 45:218, 219, 220, 1906.

Scapes short and fairly slender (7.5–10 cm. high, about 6–7 mm. thick), several (1–5) from a rather small more or less globose rhizome (about 2.5 cm. thick); color lemon yellow; male flowers scattered, below the pistillate spadix; androecium transversely oblong, with up to 7–8 hexagonal loculi; pistillate spadix elliptic-ovoid, about 2.5 cm. long and about 9 mm. thick; pistils short stipitate; spadicels obovate ("tailed"). Christmas Island (East Indies). (N. V.)

II. B. Inflorescences unisexual (dioecious)

8. *A. polyandrum* (Griffith) comb. nov.

Balanophora (*Polyplethia*) *polyandra* Griffith, Trans. Linn. Soc. London, 20:94, pl. 7, 1851; J. D. Hooker, *ibid.*, 22:47, 1859. *Polyplethia polyandra* Van Tieghem, Ann. Sci. Nat.. Bot., ser. 9, 6:194, 1907.

Scapes low and proportionally rather stout (9–12 cm. high, 1–1.5 cm. thick), from a lobed rhizome; male flowers distant in loose whorls; androecium transversely oblong, with the very numerous loculi (20–35, *fide iconibus*) hexagonal; female flowers dense, in a broadly ellipsoideoconic spadix; pistils short stipitate, styles not twisted, borne (chiefly, but not exclusively) on the pedicels of the spadicels; spadicels very broadly obovate, long and stoutly pedicellate, with flattened, margined upper surface and sides angular. Khasia Hills, Assam, India. (N. V.)

9. *A. spicatum* (Hayata) comb. nov.

Balanophora spicata Hayata, Jour. Coll. Sci. Imp. Univ. Tokyo, 25:192, pl. 33, 1908.

Scapes slender (male scape 14 cm. high, 5 mm. thick, "female" 7 cm. high,

5 mm. thick), from a fairly simple, short, curved rhizome (*fide iconibus*); male flowers distantly spaced in more or less distant and alternating whorls, on an elongated (about 5 cm. high) spadix; androecium of about 15 loculi in two series; female flowers densely crowded on a short (1.5 cm. high) ellipsoid-obovoid spadix; pistils short stipitate, crowded on the pedicels of the spadicels; spadicels with long slender pedicels, ovoid-globose, with broad blunt apiculum. Formosa. (N. V.)

EXPLANATION OF PLATES

PLATE 16

Acroblastum pallens Solander

1. Habit of single plant. × nat. size.
2. Androecial flower bud, just opening, seen from above. × 10 diam.
3. Open androecial flower, seen from above, with segments of androecium not yet dehiscent. × 10 diam.
4. Similar to 3.
5. Similar to 3.
6. Surface of a part of the gynoecial portion of the spadix, showing tips of gynoecia (dots) surrounding the tips of the spadicels. × 10 diam.
7. Three pistils (showing wholly or in part) and surrounding but not attached to the single spadicel. × 80 diam.

Drawn by Miss Anna Hamilton.

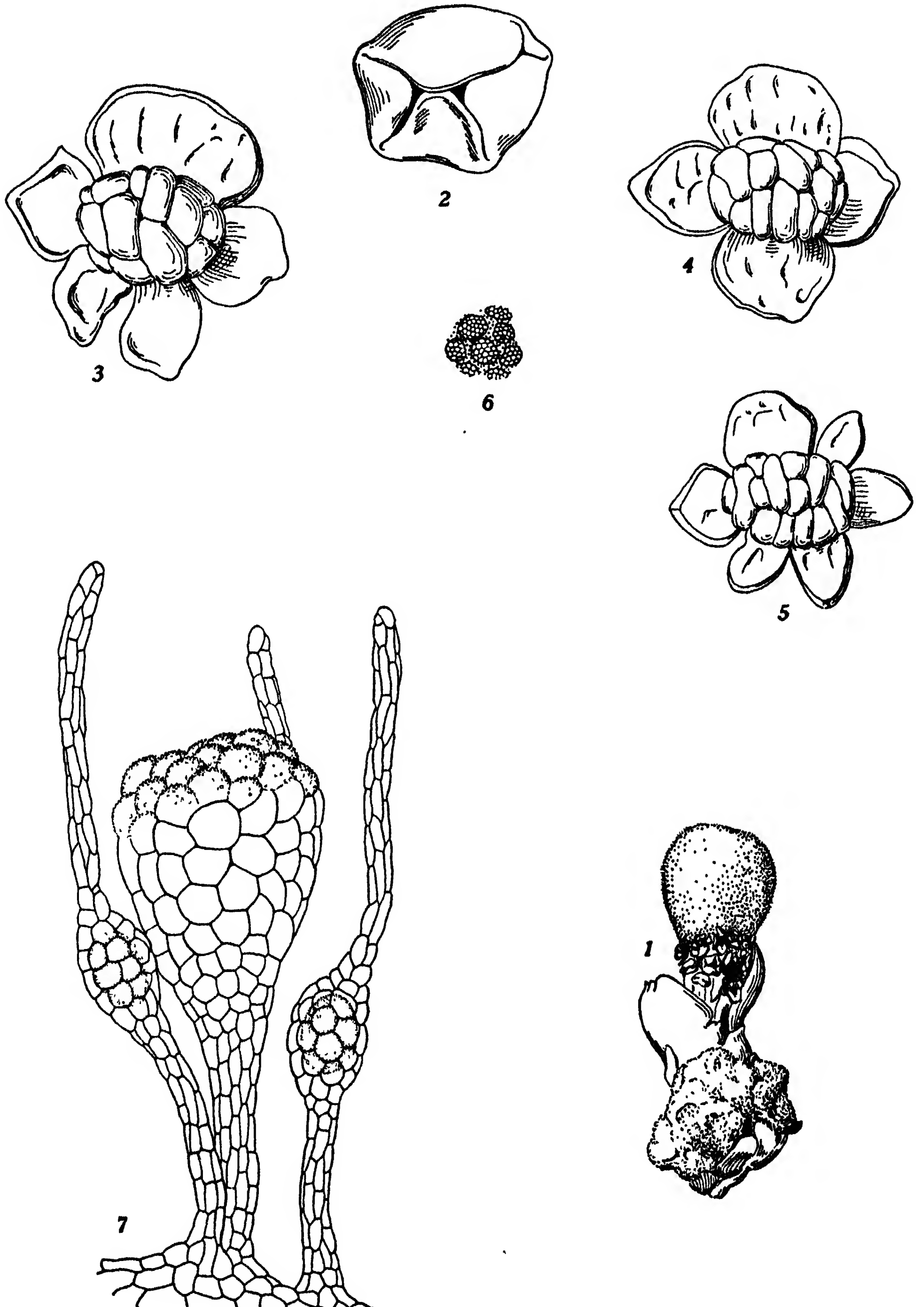
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PLATE 17

Acroblastum Wilderi (Setchell) Setchell

1. Surface view of single segment (or branch) of a rhizome with its erect flowering stem. × nat. size.
2. Same specimen as shown in figure 1, split lengthwise, seen from the cut surface. × nat. size.
3. Lateral view of a part of the androecial portion of the spadix, showing bracts and androecial flowers. × 10 diam.
4, 5, 6. Surface view of androecial flowers, to show variation in numerical plan; androecia not yet dehiscent. × 10 diam.
7. Similar view of androecial flower with collapsed androecium. × 10 diam.
8. Surface view of parts of the gynoecial portion of the spadix, showing tips of the pistils (dots) surrounding the tips of the spadicels. × 10 diam.
9. A single spadicel bearing pistils both on its pedicel and around its base. × 80 diam.

Drawn by Miss Anna Hamilton.

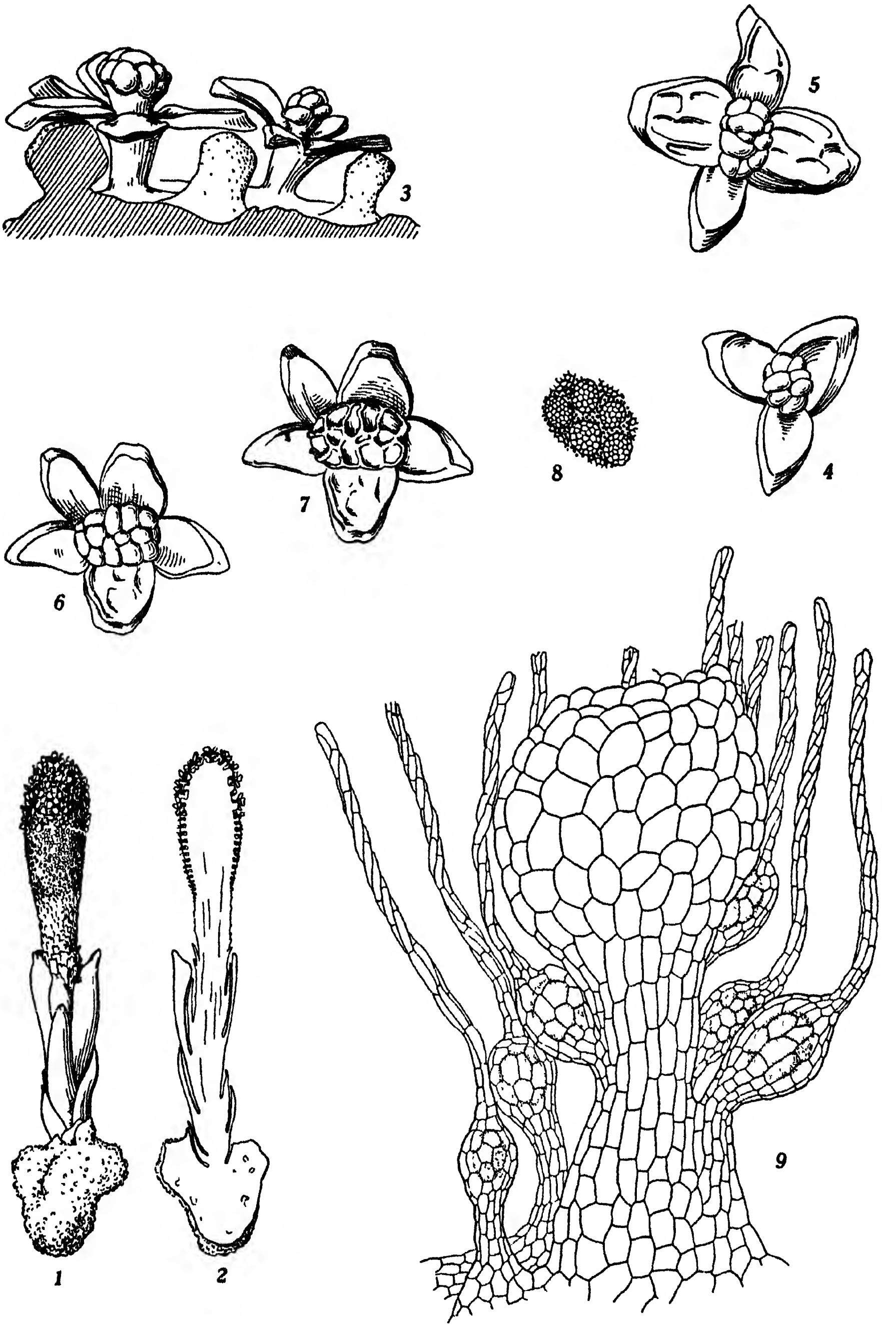
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PLATE 18

Acroblastum Wilderi (Setchell) Setchell

Rarotonga.

1. Type plant collected by Gerrit P. Wilder. (Photo does not bring out the lenticels on the rhizome.) Photo, Gerrit P. Wilder.
2. Young plants collected by Harold E. and Susan Thew Parks. (Photo, by W. C. Matthews, shows branching and lenticels.)

1

2

PLATE 19

Aeroblastum parvus (Hayata) Setchell et Yamamoto

Formosa; Mount Reitozan (Keitao), about 4000 ft. alt.; parasitic on roots of some species of *Pilea* and *Elatostema*, coll. Y. Yamamoto and S. Kamikoti, Oct. 24, 1933.

1. Gynoecial plant
2. Androecial plant.

Photo Y. Yamamoto.

COMPARATIVE HISTOGENESIS OF FOLIAR TRANSITION FORMS IN CARYA

BY

ADRIANCE S. FOSTER

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CONTENTS

COMPARATIVE HISTOGENESIS OF FOLIAR TRANSITION FORMS IN CARYA

BY

ADRIANCE S. FOSTER

INTRODUCTION

Bud scale, foliage leaf, and bract in many angiosperms represent discrete foliar types which can be readily characterized both morphologically and anatomically. Very often, however, these organ categories show considerable intergradation on the same shoot and morphological demarcation becomes correspondingly arbitrary (Schulze, 1934). The widespread occurrence of intermediate or transition foliar types has provoked considerable morphological speculation and, as is well known, constitutes the basis for the theory of metamorphosis (Foster, 1928). This theory, in one form or another, has influenced morphological thought from the time of Goethe (Hansen, 1907), and even at present is a guiding principle in much of the recent research on foliar homologies (Glück, 1919; Goebel, 1932). In the writer's opinion, however, the problem of intermediate foliar types deserves more than the formal morphological treatment which it has received in the past. Indeed, foliar transition forms offer exceptionally favorable material for morphogenetic study and for a complete examination of the genetic significance of variation in the expression of organ characters. This latter question has been examined by Cook (1922, 1923, 1926), who regards transition forms as "interorgan hybrids" which he believes may possess evolutionary significance.

The present article deals with a study of the developmental morphology and histogenesis of foliar transition forms in *Carya*. In many species of this genus, the transition forms show various intergradations between the pinnate foliage leaf and the bladeless cataphyll and are thus favorable for study. Particular emphasis will be placed upon the type, position, and duration of meristems as factors conditioning the variation in form and structure of the adult organ. This viewpoint has already been adopted with success in an analysis of the histogenetic divergence between bud scale and foliage leaf in *Carya Buckleyi* var. *arkansana* Sarg. (Foster, 1935).

MATERIALS AND METHODS

Of the four species of *Carya* selected for study, *C. Buckleyi* var. *arkansana* Sarg. has received the most attention. Histogenetic data for this species are based upon preparations used in a previous study (Foster, 1935, p. 89) as well as upon additional bud material collected from the same tree in April, 1934. The material of *C. alba* K. Koch, *C. laciniosa* Schn., and *C. ovata* K. Koch was

obtained at the same time through the kindly assistance and coöperation of Mr. G. M. Brown, of Van Buren, Arkansas. All the 1934 collections of these four species were killed and fixed by the previous technique (Foster, *loc. cit.*) and the serial sections (8μ in thickness) stained by the use of tannic acid and iron chloride in conjunction with safranin (Foster, 1934).

INVESTIGATION

MORPHOLOGY OF TRANSITION FORMS

In all the species investigated, the transition from the last pinnate foliage leaf of the shoot to the bladeless scales of the terminal bud is marked by the formation of two or more intermediate foliar structures. These "upper transition forms" vary from deltoid to broadly ovate in form and consist of a prominent sheathlike region terminating in a more or less rudimentary lamina (pl. 21, fig. 6). The lamina varies considerably in size and degree of development. In *C. Buckleyi* var. *arkansana,* for example, it may consist of the midrib region of a median and two smaller lateral leaflets with but little indication of blade development. Frequently, in this species, the lamina region is represented by a single apical pointlet which appears to correspond to the median leaflet (Foster, 1931, pp. 867–868, Pl. LXI, figs. 1–3). Similar variations in the organization of the lamina have been observed in the other species. It is noteworthy that vigorous growth, such as occurs in coppice shoots, results in the development of a larger and aparently functional lamina. The sublaminar vaginate region of the transition forms consists of a prominent median axial region, dorsally keeled and flanked by two clearly demarcated wings (cf. Foster, *op. cit.,* Pl. LXIII, fig. 2, and Trelease, 1896, pl. 14, fig. 7; pl. 15, figs. 4, 6, 7).

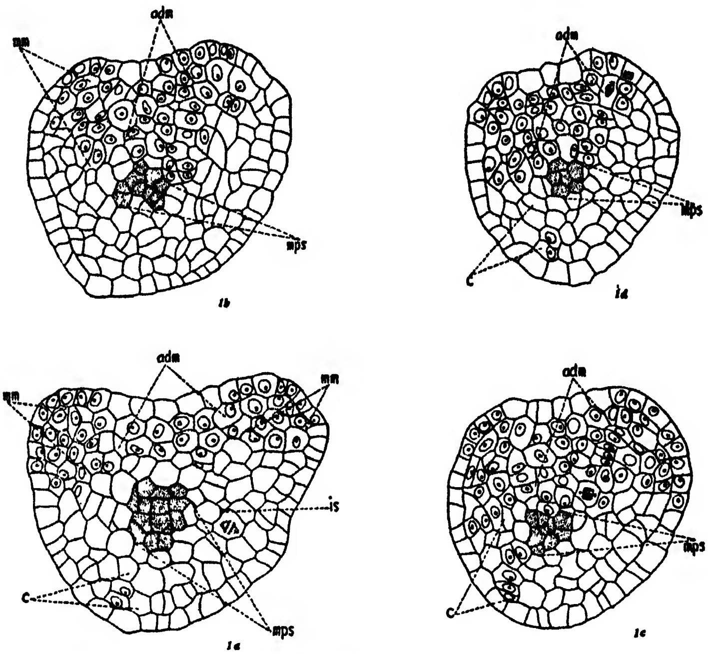
This brief morphological resumé clearly indicates that *wing formation,* characteristic of the bud scale, and *rib* and *blade formation,* characteristic of the foliage leaf, are combined in varying degrees in the transition forms. The histogenetic processes which condition this interesting blend of morphological characters will now be described.

ORIGIN AND EARLY HISTOGENESIS OF THE PRIMORDIA

In *C. Buckleyi* var. *arkansana* the primordia of the transition forms appear in summer and are clearly recognizable at the growing point of the winter bud as semimeristematic structures varying in their degree of morphological differentiation. Occasionally, the primordium shows a demarcation into leaflet initials and a slightly broadened basal region. More often, however, the primordia are relatively broad-based and unsegmented (Foster, 1932, Pl. II, figs. 1–2).

Coincident with the swelling of the terminal bud in early spring the primordia of the transition forms resume active growth. Text figure 1 represents an early stage in development of a primordium and illustrates the beginning of the significant combination of scale and foliage leaf histogenesis charac-

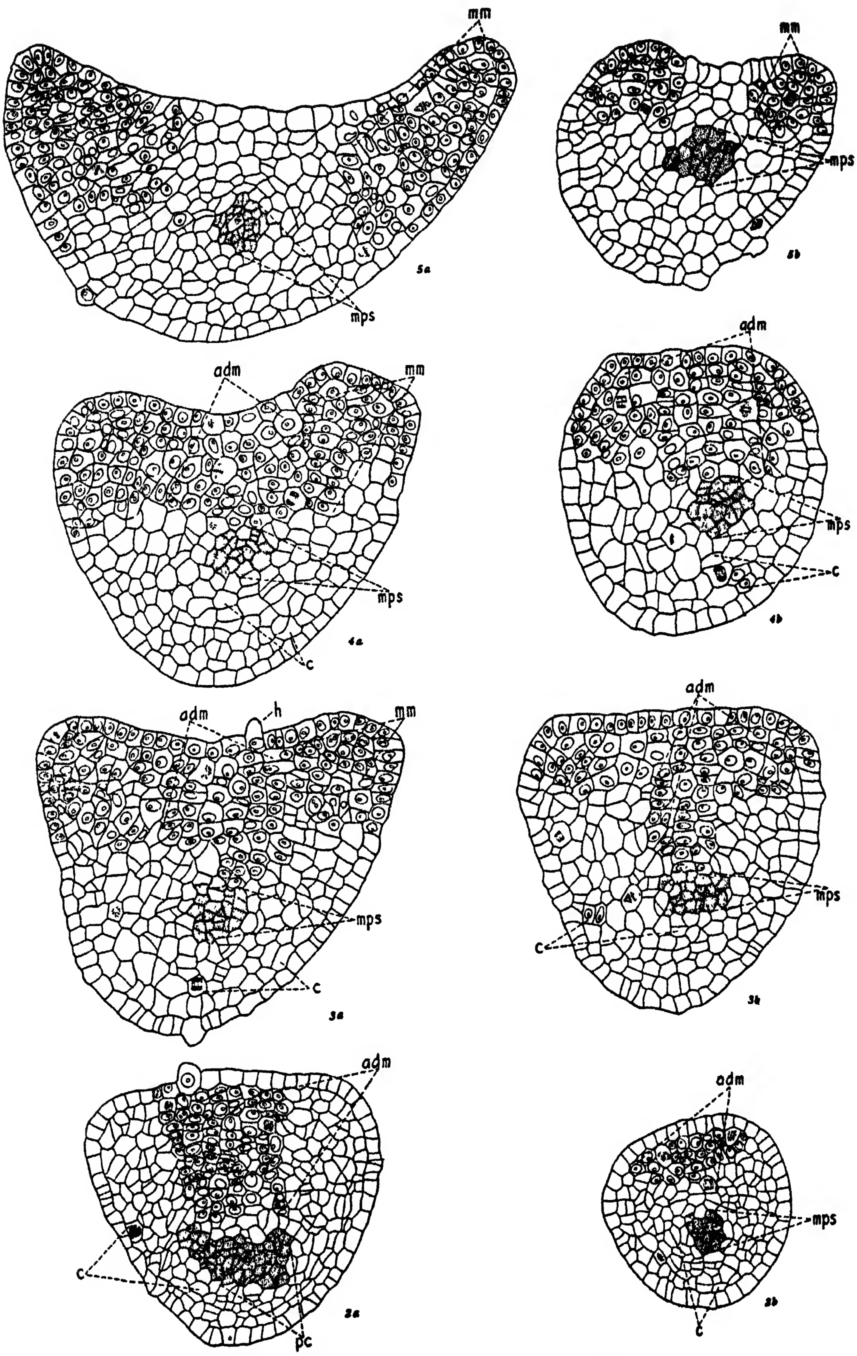
teristic of the transition form. The extreme basal region of this primordium (text fig. 1*a*) possesses a typical marginal meristem, the behavior of which is similar to that characteristic of the young bud scale, but less active (cf. Foster, 1935, pl. 2, figs. 3*b*, 4). At the same level, adaxial meristematic activity is also apparent as well as clear evidence of periclinal divisions in the abaxial and lateral regions of the cortex. This type of histogenesis produces a marked increase in the radial thickness of the primordium and simulates the early histogenesis of the foliage leaf (cf. Foster, 1935, text fig. 49*a*). Transverse



Figs. 1*a–d*. Transverse sections at levels respectively of 40, 60, 70, and 80μ from base, of primordium of transition form (150μ high). Legend: *adm*, adaxial meristem; *c*, young cortex; *is*, intercellular space; *mm*, marginal meristem; *mps*, median procambial strand. ×225.

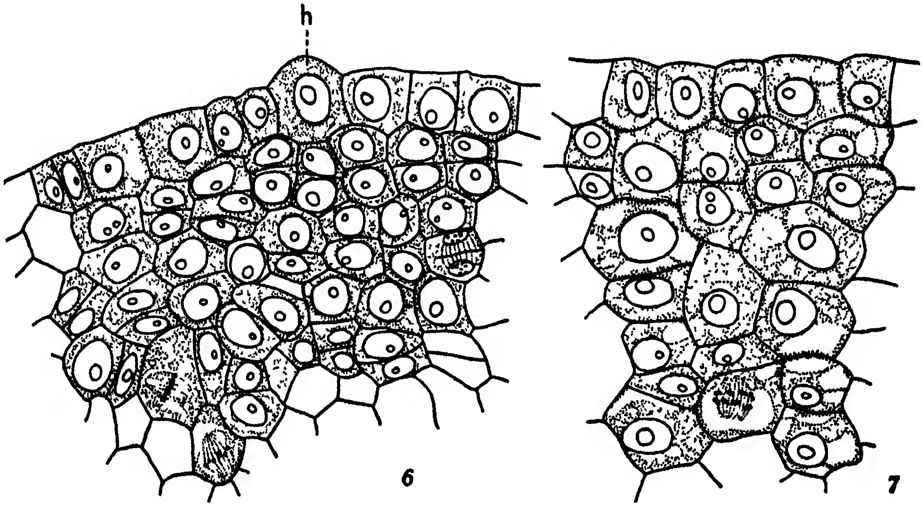
sections at higher levels through the primordium (text figs. 1*b*, *d*) reveal a marked decrease in marginal growth and an increasing prominence of peripheral increase in thickness. Indeed, except for the large, irregular, rapidly vacuolating cells of the adaxial meristem, the structure of the upper region of this primordium closely agrees with the corresponding part of a young foliage-leaf primordium (cf. Foster, 1935, text fig. 49*b*).

As differentiation continues, the demarcation between the lower and upper zones of the primordium becomes very obvious (text figs. 3, 4). In some primordia, the basal region broadens noticeably as a result of extremely active marginal growth and the increase in radial thickness of the median region is correspondingly sluggish (text fig. 4*a*). In fact, the histogenesis of this region, except for the poorly defined adaxial meristem, may closely resemble that of



Figs. 2–5. Figs. 2a–b. Transverse sections, at levels respectively of 50 and 128μ, of primordium of second foliage leaf (216μ high). Figs. 3a–b. Transverse sections, at levels respectively of 50 and 80μ from base, of primordium of transition form (210μ high); *h*, hair. Figs. 4a–b. Transverse sections, at levels respectively of 40 and 90μ from base, of primordium of transition form (190μ high). Figs. 5a–b. Transverse sections, at levels respectively of 56 and 192μ from base, of primordium of fourth bud scale (216μ high). Legend as in text figure 1. $\times 225$.

a bud-scale primordium and consequently will diverge from the structure typical of the basal portion of a young foliage leaf (cf. Foster, 1935, text figs. 28, 50). In other primordia, however, the adaxial meristem is well demarcated and active, resulting in a greater prominence of the median region of the primordium (text fig. 3*a*). Of interest is the fact that in primordia of this type, the adaxial dermatogen may form hairs, a feature peculiar to the foliage leaf but absent from all bud-scale primordia (cf. text figs. 2*a*, 3*a*, 5). The upper zone of the primordia of transition forms, 190–210μ high, meanwhile continues to undergo active increase in radial thickness, and marginal growth is



Figs. 6–7. Fig. 6. Part of adaxial meristem of foliage leaf (190μ high) at level of 60μ from base; *h*, hair. Note dense cytoplasm and relatively large nuclei in the radially arranged cell groups. Mitosis is occurring in three cells. Fig. 7. Part of adaxial meristem of transition form shown in text figure 4, at level of 80μ from its base. Note highly vacuolated cytoplasm and relatively smaller nuclei of the large, irregular cells, as compared to foliage leaf. Mitosis is occurring in a large, inner, vacuolating cell. Both figures × 783.

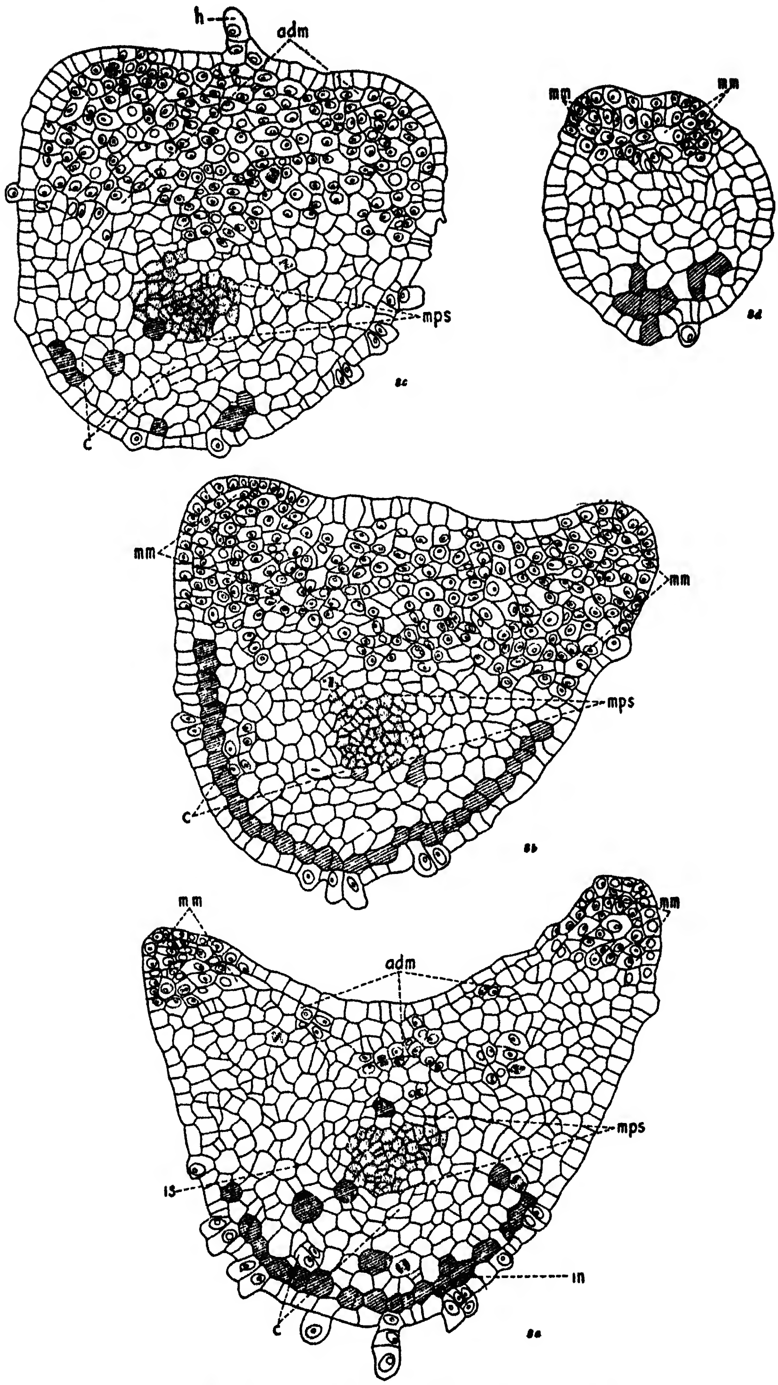
relatively inconspicuous. The adaxial meristem in this region is comparatively active and consists of radially aligned groups of irregular cells which extend to the outer edge of the median procambial strand (text figs. 3*b*, 4*b*). Text figures 6 and 7 emphasize, however, the marked contrast between the cell behavior in the adaxial meristem of the primordium of a foliage leaf and of a transition form 190μ high. In the foliage leaf, the cells of the adaxial meristem are comparatively narrow in radial diameter, possess large, centrally placed nuclei and dense cytoplasm, and are in a state of rapid division (text fig. 6). In contrast, the cells of the adaxial meristem of the transition form are noticeably larger and more irregular in shape with highly vacuolated cytoplasm and nuclei often displaced to one side of the cell (text fig. 7). These cytological features have been found to foreshadow the decidedly abbreviated period of active cell division in the adaxial meristem during the further development of the transition form. Furthermore, the early vacuolation

and enlargement of the inner cells of the adaxial meristem determine the more rapid increase in radial diameter of young transition forms as compared with that of foliage leaves of a similar size (cf. text figs. 2*b*, 3*b*, 4*b*).

DIFFERENTIATION OF WINGS AND MIDRIB

Continued increase in radial thickness accompanied by basal marginal growth soon results in a foliar structure consisting of a prominent midrib flanked by massive lateral wings (cf. Foster, 1932, Pl. II, figs. 3, 4). Text figure 8 illustrates the histogenesis characteristic of this developmental stage. Marginal growth is most pronounced in the extreme basal part, which, because of the sporadic and sluggish behavior of the adaxial meristem, is now crescentic in cross-sectional view (text fig. 8*a*). At this level, however, frequent periclinal divisions are still occurring, lateral and abaxial to the median procambial strand. This type of histogenesis, which may be traced into the upper region of the primordium, leads to the early demarcation of the dorsal keel characteristic of the transition form (text figs. 8*b*, *c*). At this stage in differentiation, the basal region is noticeably asymmetrical. As in the bud scale, this asymmetry is related to an inequality in marginal growth, the more rapidly extending wing lying in the direction of the spiral phyllotaxy of the younger foliar primordia of the bud (cf. Foster, 1935, pl. 2). At a slightly higher level (text fig. 8*b*), wing development is accompanied by an active and typical adaxial meristem. It will be seen that the radial alignment of cells, characteristic of younger phases in development of the adaxial meristem, is now in large part obscured. Cell divisions in various planes, accompanied by vacuolation and irregular cell expansion, all combine to produce a rather chaotic cell pattern. A comparable stage in the development of the transition form of *C. alba*, however, shows that the radial arrangement of the cells of the adaxial meristem may sometimes be preserved longer as a result of more uniform periclinal divisions (pl. 19, fig. 3). Evidently, specific as well as interspecific variation in the career of the adaxial meristem is to be expected. Nevertheless, the fact remains that at a relatively early stage the adaxial meristem of the transition form exhibits a marked decline in its activity as contrasted with its protracted vigor in the foliage leaf (cf. Foster, 1935, text fig. 55; pl. 6, fig. 17; pl. 7, figs. 18*a*, *b*).

In passing toward the upper zone of a young transition form, a progressive decrease occurs in the activity of the marginal meristem (text fig. 8*c*). Indeed, except for the irregular adaxial meristem and the less extensively developed procambial tissue, the structure at this level corresponds in some measure to the petiole of a young foliage leaf (cf. Foster, 1935, text fig. 55). Usually, however, the marginal meristem in this region soon becomes inactive or, at most, produces narrow, winglike extensions from the midrib. The formation of lateral leaflets from the marginal meristem, as will be shown later, occurs at a much later stage. A transverse section through the apical region (text fig. 8*d*) depicts a marked diminution and localization of active meristem. The slight adaxial groove as well as the cell pattern in the marginal



Figs. 8a–d. Transverse sections, at levels respectively of 20, 50, 80, and 260μ from base, of transition form (320μ high). Cells with stained, ergastic material represented in this and all other text figures by diagonal lines. Legend: *in*, inclusion; other abbreviations as in previous figures. $\times 225$.

meristem clearly suggests that this region is destined to develop into a more or less rudimentary median leaflet.

Attention must be drawn at this point to the highly differentiated character of the cortical tissue of the midrib. The component cells are more or less isodiametric, air spaces are appearing, and a distinctive type of ergastic material is rapidly accumulating. This ergastic material (represented in all figures by diagonal lines) is stained deep red by safranin, but appears unstained and yellowish after treatment with Delafield's haematoxylin. The inclusion

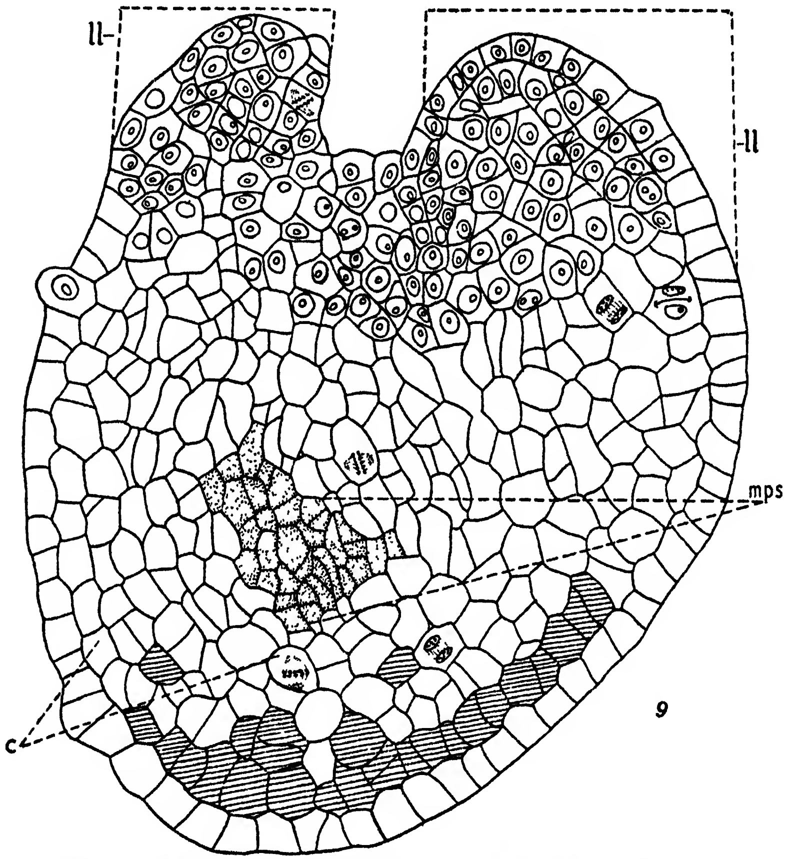


Fig. 9. Transverse section, 210μ from base, of transition form (420μ high), at level of the single pair of meristematic lateral leaflet-primordia (*ll*). Other abbreviations as in previous figures. $\times$ 450.

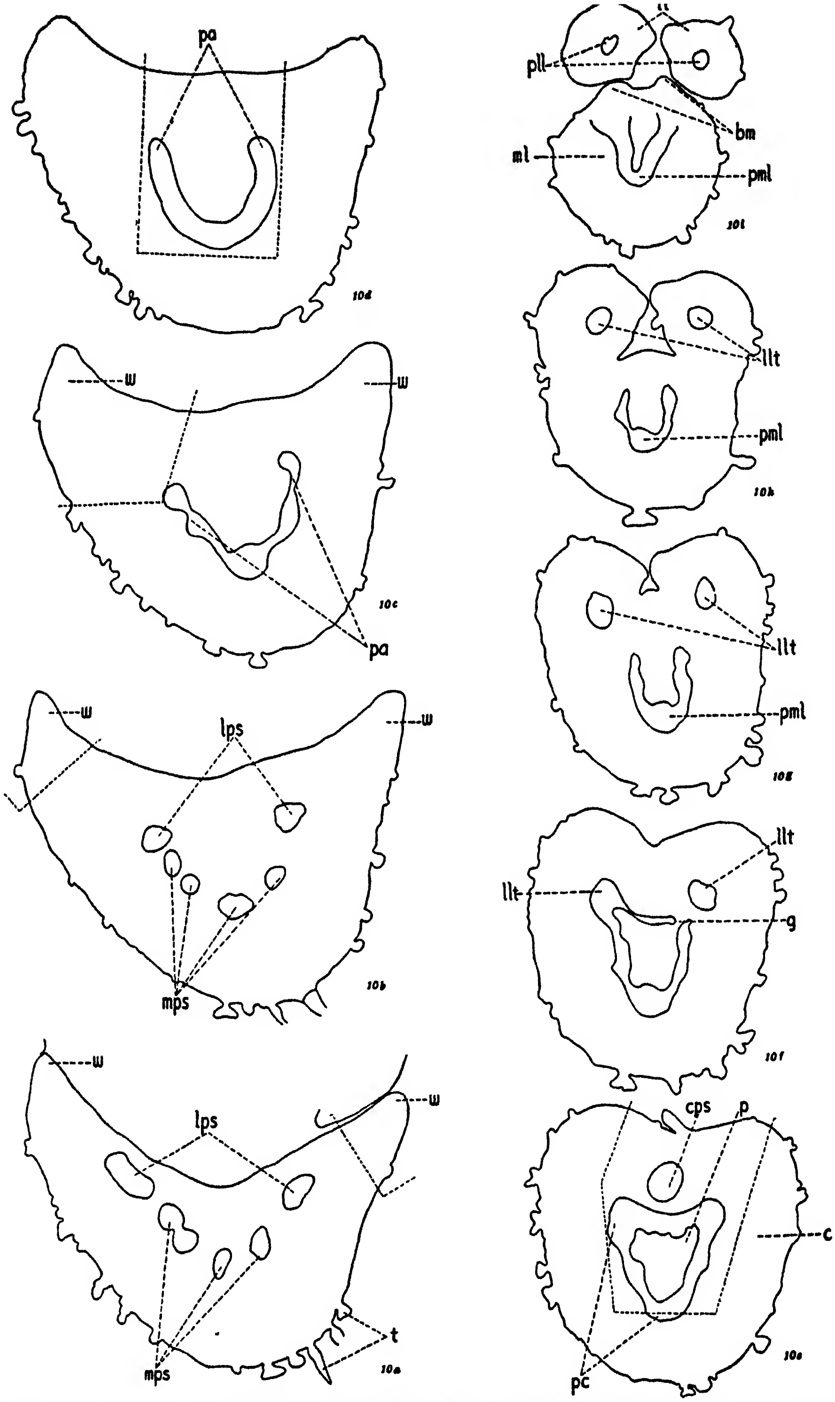
develops first in the abaxial subepidermal layer and then spreads through this layer both centrifugally and acropetally (text fig. 8). Further, it soon appears in certain isolated cells or cell groups in the vicinity of the median procambial strand. Although the nature and physiological significance of this ergastic material is unknown, it seems clear that its early formation is associated, as in the bud scale, with the characteristic rapid transition from meristem to permanent tissue. The cortical tissue of foliage leaf primordia, conversely, is free from ergastic material for a much longer period.

ORIGIN AND DIFFERENTIATION OF THE LAMINA

Sometimes the lamina of the transition form consists of a single diminutive median leaflet which differentiates from the upper region of primordia, 300–350μ high. This leaflet, when only 100μ high, is characterized by the rapid maturation of the cells of the abaxial region, many of which become highly vacuolated and acquire deeply stained inclusions. As a consequence, active meristem is closely restricted to a narrow adaxial strip, the margins of which project as two weakly defined ridges destined to form the blade meristem (text fig. 8*d*). In striking contrast, a median leaflet, similar in size, of the foliage leaf, is embryonic except for several abaxial layers of vacuolated, periclinally dividing cells. In its later development, the single leaflet of the transition form slowly elongates by apical growth, and in organs 1–1.5 mm. high may reach a length of 300–400μ. At this stage, the cortical cells of the midrib are relatively thick walled and mature. A single row of protoxylem elements (which differentiate acropetally) accompanies the small median procambial strand, and two narrow adaxial ridges of typical blade meristem occur. The latter may give rise to a minute blade which becomes thickly clothed with dense hair; but apparently this is exceptional.

More commonly, however, a lamina of three leaflets is formed. The lateral leaflets result, as in the foliage leaf, from a local increase in volume of the cells of the marginal meristem and, in primordia, 400–450μ high, appear as two hemispherical swellings, 20–30μ high (text fig. 9). In the subsequent development of the transition form, at least in *C. Buckleyi* var. *arkansana,* no additional lateral leaflets are formed. This situation presents a striking contrast to the foliage-leaf primordium, which at a height of 300–400μ forms two or three pairs of lateral leaflets in rapid acropetal succession (cf. Foster, 1935, text figs. 52, 53).

In transition forms with three leaflets, the median leaflet, from the beginning, grows more rapidly and becomes more highly differentiated than the diminutive laterals. For a time, varying with the organ, its rate of elongation parallels that of the sublaminar region. In organs 0.7–1 mm. high, however, the elongation of the median leaflet decreases in favor of the dominant growth of the lower vaginate part. Text figure 11*i* depicts the histogenesis occurring in the basal region of a median leaflet, 360μ high. As in a similar developmental stage of the unifoliate lamina, the cortical tissue of the midrib is highly differentiated, and a large proportion of the cells contain ergastic material. At this level, two adaxial ridges of meristem capable of forming a blade are evident, their inner cells merging with the open edges of the arc-shaped procambial strand. Transverse sections through the median region of this leaflet reveal a similar histology, except for a greater prominence of the blade meristem. The characteristic rapid maturation of the cortical tissue of the midrib becomes increasingly evident and at a much later stage the component cells are thick walled and are rapidly losing their ability for further division. At this time, the contrast between the highly differentiated



Figs. 10*a–i*. Transverse sections, at levels respectively of 20, 80, 130, 160, 330, 360, 390, 410, and 460μ from base, of transition form (730μ high). Legend: *bm*, blade meristem; *c*, cortex; *cps*, cortical procambial strand; *g*, gap; *ll*, lateral leaflets; *llt*, lateral leaflet trace; *lps*, lateral procambial strands; *ml*, median leaflet; *mps*, median procambial strand; *p*, pith; *pa*, procambial arc; *pc*, procambial cylinder; *pll*, procambium of lateral leaflets; *pml*, procambium of median leaflet; *t*, trichomes; *w*, wing. $\times 100$.

midrib, with its rudimentary and still embryonic vascular strand and the two prominent ridges of blade meristem, is striking (pl. 19, fig. 2). A comparison with the median leaflet of the foliage leaf shows that cell divisions are more protracted and differentiation more leisurely throughout the early development of the midrib and that, correlatively, the blade meristem from the beginning is more extensive and active (cf. Foster, 1935, pl. 8, figs. 21*a*, *b*).

While the median leaflet is developing, the primordia of the lateral leaflets may differentiate into a diminutive midrib and two ridges of blade meristem (text fig. 10*i*; pl. 19, fig. 2). As in the median leaflet, the abaxial cortical cells of the midrib mature rapidly, acquire thick walls, and soon lose their ability to divide; and the blade meristem is proportionally rudimentary and rarely develops further. An instructive example of an unusually precocious maturation of lateral leaflets is shown in a transition form in *C. ovata*. Its lateral leaflets, although only 136μ high, are morphologically undifferentiated and consist of thick walled, highly mature cells. The only type of meristem present is represented by the rudimentary median procambial strand in the base of each leaflet. The lateral leaflets of the inner transition forms in *C. laciniosa* may be, likewise, very rudimentary. In several forms studied, only one of the pair developed independently, the other remaining very small and laterally joined at its base with the median leaflet, a condition also noted in one series in *C. Buckleyi* var. *arkansana*.

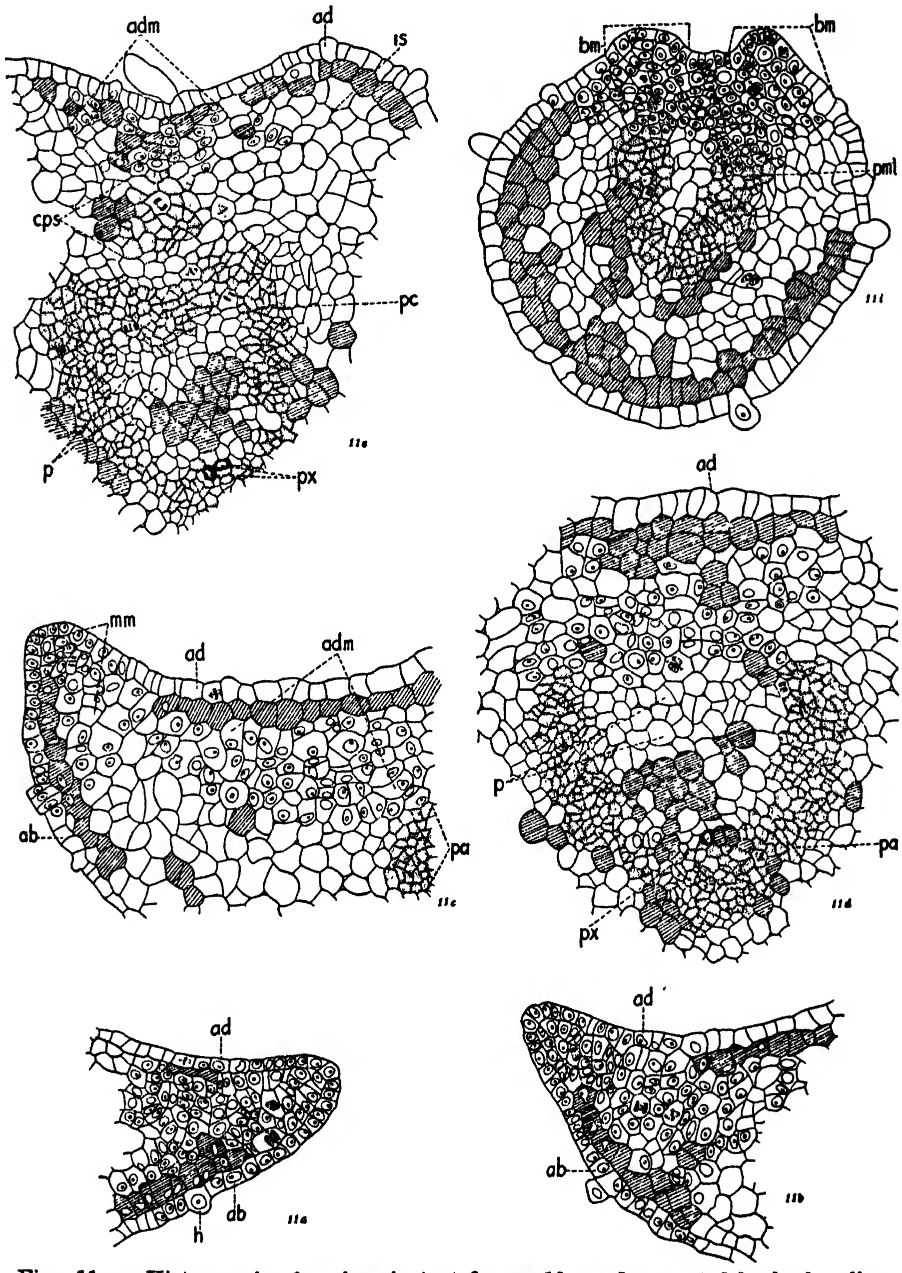
When the transition form is less than 2 mm. high, the rudimentary blade meristem of even the median leaflet exhibits a marked decline in its activity. Deeply stained inclusions begin to appear and the nuclei of the cells in various layers become reddish brown in color and degenerate in appearance. These changes presage the early cessation of all further growth, except the further development of hairs and colleters, which form a dense covering over the leaflets.

MATURATION OF THE SUBLAMINAR REGION

In the sluggish growth and final senescence of the leaflets, several significant histogenetic processes occur in the sublaminar region of the transition form. For clarity and emphasis, these processes will be described separately, as follows:

Wing development.—In *C. Buckleyi* var. *arkansana*, clear evidence of a marked decline in the activity of the marginal meristem may be seen in organs 700–800μ high. Text figures 11*a*, *b* depict the histogenesis characteristic of the basal region of the wings in a transition form 730μ high. It will be noted that a typical marginal meristem, in which cell formation is occurring, is restricted to a narrow band at the very edges of the wings and is merged abruptly into a region of rapidly maturing cells. This sudden transition from meristem to differentiated tissue is particularly emphasized by the formation of deeply stained inclusions in both subepidermal layers in the outer edges of the wing, a situation exactly duplicated in the differentiation of the bud scale (Foster, 1935, pl. 4, fig. 11). At successively higher levels, the mar-

ginal meristem becomes more and more limited in amount and, in the middle part of the sublaminar region, consists of a few sluggishly dividing cells, in direct contact with the highly differentiated tissue of the narrow wing (text fig. 11*c*). A short distance above this point, a marginal meristem is absent and the subepidermal layers, with their prominent inclusions, constitute a con-



Figs. 11*a–e*. Histogenesis of regions in text figures 10*a–e*, demarcated by broken lines. Fig. 11*i*, histogenesis of median leaflet shown in figure 10*i*. Legend: *ab*, abaxial epidermis; *ad*, adaxial epidermis; *px*, protoxylem; other abbreviations as in previous figures. × 225.

tinuous marginal band (text fig. 10*d*). In transition forms, 1–2 mm. high, the basipetal maturation of the wing tissue is very striking and a marginal meristem is confined to the extreme basal portion (cf. Foster, 1935, pl. 2, fig. 3*a*, outer organ at right). Thus in *C. Buckleyi* var. *arkansana* the career of the marginal meristem is relatively brief, resulting in narrow wings at maturity. In contrast, the transition forms of *C. laciniosa* and *C. ovata* develop thinner and more extensive wings because of the proportionally more extended period of marginal growth which obtains. In both species, a band of typical submarginal initial cells is evident from which three internal layers of vacuolating and dividing cells originate (pl. 20, figs. 4, 5). This marked emphasis on growth in the surface of the wing simulates the histogenesis typical of late phases of bud-scale development and diverges from the irregular cell pattern found in the transition form of *C. Buckleyi* var. *arkansana* (cf. Foster, 1935, text figs. 37–41). As in this species, however, the subepidermal cells of the wings of transition forms in *C. ovata* and *C. laciniosa* eventually mature centrifugally and rapidly acquire thick walls and stained inclusions.

Midrib development.—Wing development is accompanied by the continued rapid differentiation and maturation of tissue in the midrib region. In contrast to the basipetal decline in the activity of the marginal meristem, the maturation of the adaxial meristem proceeds acropetally. In the basal region of transition forms of *C. Buckleyi* var. *arkansana*, 700–800μ high, the adaxial subepidermal layers of cells are highly differentiated with no signs of regular periclinal divisions. In the median region, however, a typical adaxial meristem of irregular, highly vacuolated cells is found (text fig. 11*c*). At this level, clear evidence of the rapid transition to permanent tissue is supplied by the senescence of the outermost layer of the adaxial meristem, the large cells of which already have formed inclusions. Thus, at this point, as well as at higher levels, cell divisions are confined to the inner region of the sluggish adaxial meristem, and growth in thickness is comparatively insignificant (text figs. 11*d, e*). The stage at which cell divisions cease in the adaxial meristem varies considerably. In *C. Buckleyi* var. *arkansana,* the radial alignment of cell groups may disappear before the organ is 1.5 mm. high. In *C. laciniosa,* however, and to a less degree in *C. ovata,* the adaxial meristem, except for one or two mature outer layers, remains quite active in organs of a similar size (pl. 20, figs. 4–5). Obviously, both species are distinguished from *C. Buckleyi* var. *arkansana* by a less abbreviated differentiation of the wings and midrib. The cortical tissue of the abaxial and lateral regions of the midrib in all species investigated undergoes far-reaching changes in later developmental stages and its subepidermal layers, particularly, become thick walled and filled with stained inclusions (pl. 20, figs. 4–5).

Development of the vascular system.—During the histogenetic events described in this and previous sections of the paper, the distinctive vascular system of the transition form slowly differentiates. An investigation of a large number of bud series shows considerable variation in the mode of differentiation of the procambium and its subsequent maturation to xylem and

phloem. Only the more general features of this complex problem can be examined here and further study, particularly of late stages of differentiation, is postponed.

The transition form, like the bud scale and the foliage leaf, possesses a trilacunar node. The median trace originates first, appearing in the base of very young primordia, at which point it differentiates acropetally and basipetally (text figs. 1, 3, 8). As in the bud scale, the lateral traces develop from vacuolating cells in the basal region of primordia, 200–250μ high, and differentiate both downward toward the stele and upward into the primordium. Unlike the palmately arranged, dichotomizing, procambial strands typical of the young bud scale, however, the further differentiation of the vascular system of a transition form approaches, in varying degrees, that obtaining in the foliage leaf (Foster, 1935, pp. 120 and 123 and pl. 7, fig. 19). Text figure 10 shows a condition very frequently occurring in organs 700–800μ high. In the basal region, the five branches derived from the median tripartite trace and the lateral traces are arranged in a median crescentic series (text figs. 10*a*, *b*). At a higher level (text fig. 10*c*), the previously discrete strands become laterally connected by procambial tissue into a continuous arc. This condition resembles the procambial arc formed at a much earlier developmental period in the foliage leaf (cf. Foster, 1935, text fig. 55). Progressing upward, the edges of the procambial arc gradually become connected by a tangential strip of periclinally dividing cells (text figs. 10*d*, 11*d*). The latter originate, as in the foliage leaf, from the innermost cells of the adaxial meristem. This tangential strip of cells, at a higher level, differentiates into small, typical procambial cells, so that the main vascular system, just below the lamina, is stelar in organization (text figs. 10*e*, 11*e*). Further, at this point, a diminutive, accessory, procambial strand is actively differentiating in the adaxial cortex. Serial sections indicate that the further development of this accessory, cortical strand is both basipetal and acropetal. In its basipetal differentiation, it ultimately joins the adaxial side of the main procambial cylinder at a lower level, leaving a distinct gap above its point of insertion. Acropetally, its development is closely related to the differentiation of the lateral leaflets. Text figures 10*f* and 10*h* show that at this stage the accessory strand has not yet reached the lamina, each lateral leaflet of which, first of all, receives a "trace" from the main stele. At a later stage, the accessory strand completes its acropetal elongation and forks at the base of the lamina, each branch innervating a lateral leaflet (pl. 19, fig. 1, outer trans. form).

The early developmental history of the vascular system just outlined is common in outer transition forms of *C. Buckleyi* var. *arkansana* and *C. laciniosa*. Several variations from this condition have been investigated in the former species, however, and are worth recording. In one variation, as many as four diminutive, accessory cortical strands occur, in addition to the small, main, procambial cylinder. These strands run parallel for a considerable distance, ultimately merging into a single bundle. The latter forks at the base of the lamina and its two branches represent the sole vascular supply of the two

small lateral leaflets. The main procambial cylinder progressively contracts in size toward the lamina and, at the base of the median leaflet, presents the structure of a young amphicribral bundle with a central strand of protoxylem surrounded by procambium. In other variations, an accessory, cortical bundle fails to differentiate. Under such circumstances, the vascular system in the upper region may consist of a small stele, the adaxial half of which diverges outward at the base of the lamina where it forks, forming the vascular supply of the lateral leaflets; the remainder of the procambial tissue appearing as an amphicribral bundle then extends into the median leaflet (pl. 19, fig. 1, inner trans. form). When the lamina is unifoliolate, the vascular system is proportionally modified and even the stelar organization may be omitted in favor of a central bundle formed by the merging of the lateral traces with the median.

The variable and complex organization of the vascular system of the transition form offers interesting points of contrast with that of the foliage-leaf axis. In *C. Buckleyi* var. *arkansana,* transverse sections through the base of the petiole show the departure, from the main stele, of two collateral bundles which diverge into the adaxial cortex and soon unite to form a small ectophloic "siphonostele." The latter then extends, parallel to the main vascular cylinder, throughout the major part of the petiole. Thus the vascular plan of the petiole agrees fundamentally with that characteristic of the upper midrib region of the transition form, except that in the latter a cortical bundle, rather than a stele, is present (text figs. 10*e*, 11*e*). Just below the point of attachment of the lowest pair of leaflets of the foliage leaf, the adaxial stele divides into two smaller steles. This behavior corresponds to the forking of the cortical bundle at the base of the lateral leaflets of the transition form. In the foliage leaf, however, only a part of each accessory stele, together with the "traces" from the main cylinder, innervates each of the lowest pair of leaflets. The remaining parts of the accessory steles then continue into the rhachis, where they often fuse after a short distance. This brief comparison clearly indicates the close agreement between the degree of lamina differentiation and the general plan of the vascular system in the foliage leaf and in the transition form. It seems clear that the number and vigor of development of lateral leaflets in each type of organ condition particularly the structure and behavior of the cortical vascular system. A further study of this relationship would doubtless throw light upon the nature of the variations in the vascular system of the transition form noted above.*

The differentiation of protoxylem begins first in the median procambial

* Troll (1935, pp. 421–423), in his recent monograph, briefly discusses the vascular structure of the leaf axis in pinnate leaves. He states, apparently in reference to certain Umbelliferae, that vascular "anastomoses" are present at the points of insertion of the leaflets on the rhachis. No mention is made, however, of the development or vascular organization of the leaves in the Juglandaceae, in spite of the earlier anatomical studies of De Candolle (1878, pp. 447, 473–474) and Petit (1887, pp. 249–250). This omission, in a modern comparative treatise, of éven a reference to a family characterized throughout by its pinnate leaves is surprising, especially in view of the author's contention (*op. cit.*, pp. 349–378) that both the divergent and the acropetal types of pinnate leaves are modifications of a fundamental basipetal type. Although *C. Buckleyi* var. *arkansana* possesses a typical acrop-

bundle at the base of the primordium and proceeds acropetally. In organs 700–800μ high, one or two files of protoxylem elements may be detected as high as the base of the lamina (text figs. 11*d, e*). In later stages of development, xylem formation becomes increasingly evident and extends as discrete strands into the midrib region of the median leaflet (pl. 19, figs. 1, 2). No effort has been made in this study to follow further stages in the development of the vascular system.

When it is mature, the sublaminar region of the transition form in *C. Buckleyi* var. *arkansana* consists of (1) an epidermal system, many cells of which have formed colleters or hairs, (2) a cortex composed of an outer zone of typical collenchyma and an inner region of large parenthyma cells, and (3) a vascular system, commonly a stele, consisting of isolated, primary, collateral bundles imbedded in a cylinder of fibers. Free-hand sections dehydrated in alcohol and cleared in xylene show that many cells of the cortex and pith contain large, solitary druses. In summer, the ground tissue of the transition form gradually becomes senescent and may die, except in a small, basal zone. Under such circumstances, the early deciduous character of the transition forms is not surprising. In *C. Buckleyi* var. *arkansana* one or both of the transition forms may be cast off in the late summer and fall (Foster, 1931, p. 866). A similar behavior also obtains in the closely related *C. arkansana* and in *C. alba,* according to field notes supplied for my use through the kindness of Mr. G. M. Brown.

DISCUSSION

The present investigation has established the significant fact that the transition forms in *Carya* develop from primordia in which the determinative histogenetic processes, associated with bud scale and foliage leaf, are simultaneously active. Stated more specifically, the primordium of a transition form is characterized by the coexistence of both a *marginal meristem,* which produces lateral wings, and an *adaxial meristem,* which conditions the prominent midrib and its main stele-like vascular system. It must be noted, however, that in one sense marginal and adaxial growth, when contemporaneous, are somewhat antagonistic processes, neither one of which continues to the extent which obtains respectively in the bud scale or the foliage leaf (text figs. 2–5). Furthermore, these contrasted types of differentiation seem more or less coördinated in that a retardation of one process is usually accompanied by an increased emphasis of the other (text figs. 3, 4). An explanation of the factors, physiological and genetical, which govern the early processes of differentiation in the transition forms is, obviously, impossible under the conditions of our present dearth of knowledge of cell behavior in general. Nevertheless, an experimental study of transition forms, along the lines fol-

etal pinnate leaf, the situation in other hickories and in *Juglans, Pterocarya, Platycarya* and *Engelhardtia* deserves careful investigation. While Troll entirely neglects the histogenetic implications of his theory, it seems to the present writer that a thorough study of meristem behavior in the primordia of the various "types" of pinnate leaves would shed considerable light upon their possible interrelationship.

lowed by Schüepp (1929, pp. 775–789), would doubtless give us a clearer insight into the whole problem.

An outstanding event in the later stages of development of the transition form is the formation of a rudimentary lamina (text figs. 9, 10, 11*i*; pl. 19, fig. 2). The latter, however, in contrast to Goebel's general view, fails to parallel, either in its time of formation or in its mode of histogenesis, leaflet development in the foliage leaf. On the contrary, its career of development is distinctively abbreviated from an early stage as a result of the rapid maturation and senescence of all tissues. This fact agrees with Schüepp's (1929, p. 765) description of lamina differentiation in the inner bud scales of *Acer pseudoplatanus* L. and would doubtless be true of the cataphylls of such genera as *Aesculus* (Foster, 1929) and *Paeonia* (Foster and Barkley, 1933). It is important to note that the precocious maturation of the lamina in the transition forms of *Carya* occurs in the general period of bud expansion in the spring. Hence, external factors are probably secondary in preventing its further expansion. It seems more likely that its diminutive size is directly correlated with the rapid formation and early maturation of all tissues in the sublaminar region of the primordium. Consequently, Goebel's (1932, pp. 1606–1608) overemphasis of the morphogenetic importance of the early "arrest" of the lamina in transition forms and bud scales is inconsistent with the known facts of development (cf. also the remarks of H. André, 1932, p. 9). On the contrary, the present study confirms the belief that a sound interpretation must rest upon a knowledge of the entire career of development of a foliar organ. In *Carya,* the growth history of the upper transition form differs from that of the foliage leaf from the beginning and is distinguished by a marked localization and restriction of all meristematic activity. This situation is likewise true of the "lower" type of transition form (Foster, 1935, pl. 5, figs. 14, 15), the histogenesis of which, particularly in the seedling, will be discussed in a future paper.

SUMMARY

1. A comparative histogenetic study has been made of the foliar transition forms in four species of hickory, namely, *C. Buckleyi* var. *arkansana, C. alba, C. laciniosa,* and *C. ovata.*

2. The adult transition form consists of a prominently winged, dorsally keeled, basal part terminating in a lamina of one or three rudimentary leaflets.

3. The early histogenesis of the primordium combines two processes normally confined respectively to the bud scale and foliage leaf, that is, active marginal growth and adaxial increase in thickness. In one sense, these processes are antagonistic, neither one continuing to the extent peculiar to the bud scale or foliage leaf. In another sense, they are more or less coördinated, an acceleration of one being accompanied by a proportional decrease in the other.

4. Marginal growth continues longest in the basal region of the primordium and leads to wing formation. In *C. ovata* and *C. laciniosa*, the wings are relatively thin and well demarcated. The shorter career of the marginal meristem in *C. Buckleyi* var. *arkansana* results in thicker and less extensive wings.

5. Adaxial increase in thickness results from a sluggish meristem composed of vacuolating and periclinally dividing cells. Contrasting with the longer career of this meristem in the foliage leaf, the outer derivative cells soon lose their original radial alignment, acquire inclusions, and rapidly become mature in appearance. Adaxial meristematic activity persists longest in the median region of the transition form and is more pronounced, at comparable stages, in *C. alba*, *C. laciniosa* and *C. ovata* than in *C. Buckleyi* var. *arkansana*.

6. The dorsal keel of the transition form is early demarcated by periclinal divisions in the abaxial and lateral cortex of the midrib. The rapid cell maturation, typical of this region, is accompanied by the accumulation of deeply stained, ergastic material in the subepidermal layers and in scattered cells near the procambial tissue.

7. When the primordium is 400–450μ high, a median and two smaller lateral leaflets are formed. The latter arise from the upper region of the marginal meristem, but sometimes they fail to develop, resulting in a diminutive unifoliolate lamina. Growth in the lamina involves the differentiation, particularly in the median leaflet, of a midrib and two adaxial ridges of blade meristem. The further career of the leaflets is abbreviated as a result of the early maturation and senescence of all tissues. This is particularly true of the lateral leaflets, which may undergo little or no morphological or anatomical differentiation.

8. The vascular system of the upper midrib region usually consists of a small stele accompanied by an accessory, cortical bundle. The latter differentiates from the inner derivatives of the adaxial meristem. Each lateral leaflet is innervated by a branch from the accessory bundle, together with a "trace" derived from the main cylinder. Several variations from this condition are described, and a comparison is made with the more complex vascular plan of the petiole of the foliage leaf.

9. It is concluded that Goebel's interpretation of transition forms as "arrested formations of foliage leaves" is not consistent with the facts of development. On the contrary, the transition forms in *Carya* pursue from the beginning a divergent course of development which is characterized by the marked localization and restriction of meristematic activity and a consequent rapid maturation and senescence of all tissues.

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EXPLANATION OF PLATES

PLATE 19

Fig. 1. *Carya Buckleyi* var. *arkansana* Sarg. Transverse section through sublaminar region of the outer (left) and inner (right) transition forms, respectively 1390 and 950μ high. Note departure of lateral leaflet traces and the forking of the accessory, cortical procambial strand in the outer transition form. In the inner transition form a small procambial strand is present in the base of each lateral leaflet, and protoxylem may be seen in the larger concentric bundle of the median leaflet. The apical region of the first bud scale appears in the upper center of the figure. × 114.

Fig. 2. *Carya Buckleyi* var. *arkansana* Sarg. Transverse section through the lower region of the leaflets of a transition form 1264 μ high. Note the clear differentiation in the median leaflet (at left) of midrib and two adaxial ridges of blade meristem. The smaller lateral leaflets show a similar but more rudimentary structure. × 173.

Fig. 3. *Carya alba* K. Koch. Transverse section of a transition form (504μ high) at level of 144μ from its base. Note that the adaxial and marginal meristems, which are usually confined respectively to foliage leaf and bud-scale primordia, are both active in this organ. The median procambial strand is visible in the lower center of the figure. × 179.

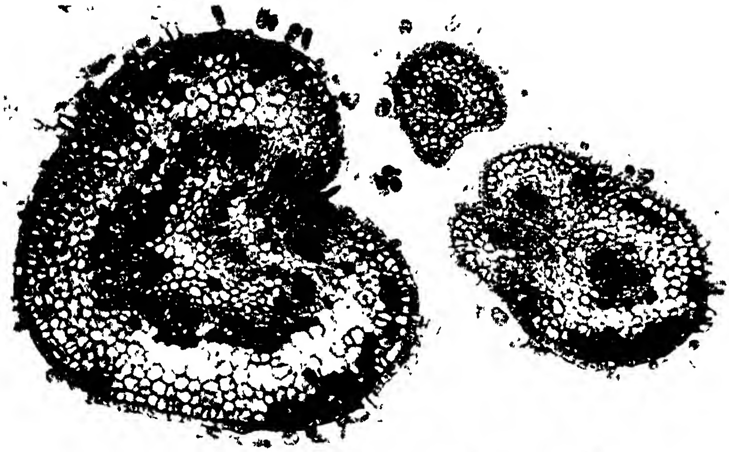

Fig. 1

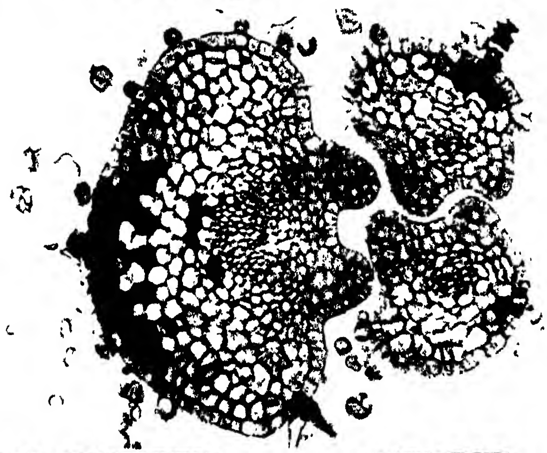

Fig. 2

Fig. 3

PLATE 20

Fig. 4*a*. *Carya laciniosa* Schn. Transverse section through a terminal bud 96μ above the apex of the growing point. The first three organs are transition forms and possess small apical laminae; the three inner organs are typical scales. Note particularly the progressive decrease in the amount of adaxial meristem and the increasing emphasis on wing formation in passing from the outer transition form (at left) to the inner organs. Protoxylem will be seen in the median adaxial region of the procambial tissue in each transition form. × 96.

Fig. 4*b*. As above. More highly magnified view of the second transition form (1264μ high) shown in figure 4*a*, at level of 204μ from its base. Note the clear demarcation between the thin, rapidly growing wings and the highly differentiated median region with its characteristic sluggish adaxial meristem. The adaxial epidermis and the layer beneath it are composed of thick walled inactive cells. Three protoxylem elements are visible at the lower adaxial edge of the procambial arc. × 145.

Fig. 5. *Carya ovata* K. Koch. Transverse section of a transition form (1552μ high) at level of 264μ from base. Note the general similarity between this organ and the one shown in figure 4*b*. At this level, the procambial tissue appears as five discrete strands, the central one with several protoxylem elements. The inner organs, partly enclosed by this transition form, are bud scales and exhibit typical and active marginal growth. × 87.

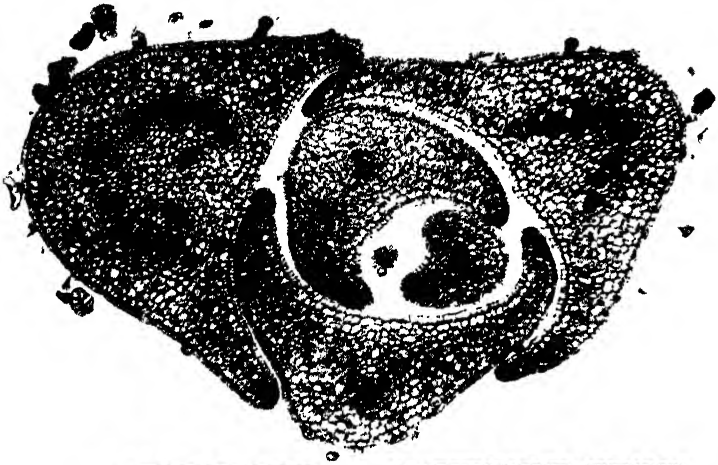

Fig. 4*a*

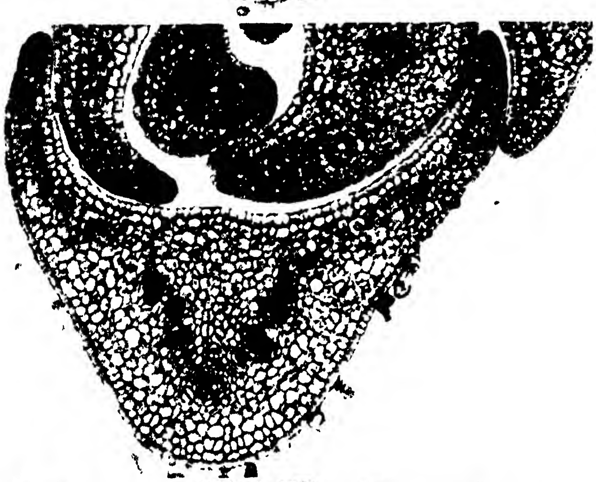

Fig. 4*b*

Fig. 5

PLATE 21

Fig. 6. *Carya alba* K. Koch. Terminal bud of vigorous shoot photographed June 1, 1934, showing, at left and right, respectively, the fully grown outer and inner transition forms. Note the rudimentary laminae embedded in hair and the clear demarcation between the midrib and the lateral wings. × 5¼.

Fig. 6

AN UNUSUAL ASCOMYCETE IN THE SHELLS OF MARINE ANIMALS

BY

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AN UNUSUAL ASCOMYCETE IN THE SHELLS OF MARINE ANIMALS

BY

LEE BONAR

THE PRESENCE of a fungus in the pitted and eroded surface of the shells of species of *Acmaea* was brought to the attention of the writer by Professor N. L. Gardner, on material he had collected on the south side of the Golden Gate at the entrance to San Francisco Bay. A study of this material showed the fruiting bodies of a pyrenomycetous form regularly present in a large percentage of the shells of these animals. Further search along the coast of central California showed that the fungus was to be found commonly present in the shells of several species of this genus, as well as in those of other animals found on the rocks of the littoral zone between the tide levels.

The surface of the shells so infested appears roughened and grayish and on examination under a lens is found to show great numbers of minute pits, many of which contain the black fruiting bodies of the fungus. This appearance is illustrated in the photograph, made under a low-power microscope. (Pl. 22, A.)

This infestation regularly starts near the apex of the shell, and very often the younger marginal part of the shell shows no involvement. The honeycombed part of the shell can be readily dissected away with needles and the fruiting bodies removed for study. The calcareous material of the shell in these areas is fragile and crumbles to a granular mass, very different from the hard, compact material of a normal shell.

Shells were decalcified in Perenyi's solution, washed, dehydrated, and imbedded in paraffin for sectioning. A study of these sections shows that there is an intricately branched network of mycelium of the fungus throughout the greater part of the shell layer, this mycelium being attached to the basal part of the fruiting bodies near the surface. Such sections show an entire disappearance of the animal matrix that is present in the uninfested part of the shell, except a very thin layer next to the animal, this matrix having been replaced by the network of the mycelium. It seems from this condition that the mycelium permeates the shell, digesting the matrix of the shell, and evidently using this material for its food. (Pl. 22, B.) There is no evidence of any damage to the animal itself by the fungus.

There is a very evident dissolving of part of the calcareous material of the shell by the mycelium at the time of this penetration, this being more complete near the outer surface, where the pits appear and where the shell may be dissected away as a crumbling mass.

The growth of this organism in such an unusual matrix, and the evident dissolving of the calcareous material in the course of its growth is a type of activity not common in fungi. It was thought that this organism might afford

interesting material for study with special reference to its calcium metabolism, since the utilization of calcium by fungi has been a disputed question, some workers making the assertion that calcium is not utilized by fungi.

Attempts were made by Miss Leonora Hohl and the writer to isolate this fungus on artificial media and grow it in pure culture. The ascospores failed to germinate in distilled water or tap water, but did germinate in sea-water preparations. Hanging drop preparations in sea water showed up to 20 per cent germination after two days, the germ tubes developing to about three to four times the length of the spore when development ceased.

A large number of single-spore isolations were made on various types of agar and gelatin media in an attempt to obtain growth. The spores germinated on the surface of such media, when this was made up with sea water, to approximately the same degree of development as in the hanging drops of sea water, but in none was continued growth obtained.

A number of different ordinary laboratory media commonly employed for the cultivation of fungi were used, with variations of the pH as well as variations of temperature and other physical factors, but all attempts to obtain continued growth and development failed.

A morphological study of the fungus shows that two types of reproductive bodies are to be found in the pitted shells, pycnidia and perithecia. These often occur in the same shell, but the perithecia are more abundant on the shells that show the greater degree of erosion, and apparently come somewhat later than the pycnidia. It seems safe to assume that these two types of fruiting bodies are the different stages in the development of one and the same fungus, and since no record of an organism similar to this has been found, it is hereby designated as a heretofore undescribed species of the genus *Didymella* Sacc.

DIDYMELLA CONCHAE sp. nov.

Diagnosis.—Perithesis in foramenis minutis, in superficies conchaerum globosis, aliquantis super planis, ostiolo pusillo perforatis; 150–200μ diam., contextu levis membranaceus, atris; ascis basilaris, latis clavatocylindricis, breve stipitatis, paries sursum crassatis, 65–80 × 15–20μ, octosporis; paraphysibus filiformibus simplexis aut ramosis; sporidiis biseriatis, ovoideo-ellipsoideis, laevis, uniseptatis, vix constrictis, hyalinis, 15–20 × 5–7μ.

Pycnidiis in foraminis similaris peritheciis, globosis, unilocularibus, contextu parenchymaticis, infra tenuis, supra crassis, poro minutis, atris, 85–110μ diam.; sporulis bacilliformis, hyalinis, 2.5–3.5 × 1–1.5μ. Sporophoris simplexis, 10μ in longitudine; in genere *Phoma.* In superficie concharum animalium marinorum: *Acmaea, Balanus, Littorina, Mitella, Tegula,* California.

Description.—Perithecia single, sunken in minute cupulate cavities, in the outer surface of shells; globoid, somewhat flattened above, with an indistinct poroid ostiole; 150–200μ in diameter; wall smooth, membranaceous, black; asci basal, broad clavate-cylindric, wall much thickened above, short stipitate, 65–80 × 15–20μ, 8-spored. Ascospores obovate-elliptic, smooth, hyaline, 2-celled, 15–20 × 5–7μ, not or slightly constricted at septum, biseriate in the ascus. Paraphyses simple or branched. 1–2μ in diameter. Text fig. 1*a*.

Pycnidia of the conidial stage situated in cavities like the perithecia; globoid, unilocular, wall membranaceous, somewhat thickened above and carbonized, 85–110μ in diameter, ostiole poroid. Conidia bacilliform, hyaline, 2.5–3.5 × 1–1.5μ. Conidiophores simple, 10μ long. Belonging to the genus *Phoma.* Text fig. 1*b*.

In outer surface of shells of marine animals, *Acmaea, Balanus, Littorina, Mitella,* and *Tegula;* California sea shore.*

Type material on *Acmaea digitalis* Eschscholz, Land's End, San Francisco, California, August 21, 1932.

Material examined:

Acmaea digitalis Eschsch., Land's End, San Francisco, Calif., Gardner, Bonar

Acmaea fenestrata Reeve, Jenner, Calif., A. R. Grant

Acmaea limatula Carpenter, Cypress Point, Carmel Bay, Calif., A. R. Grant

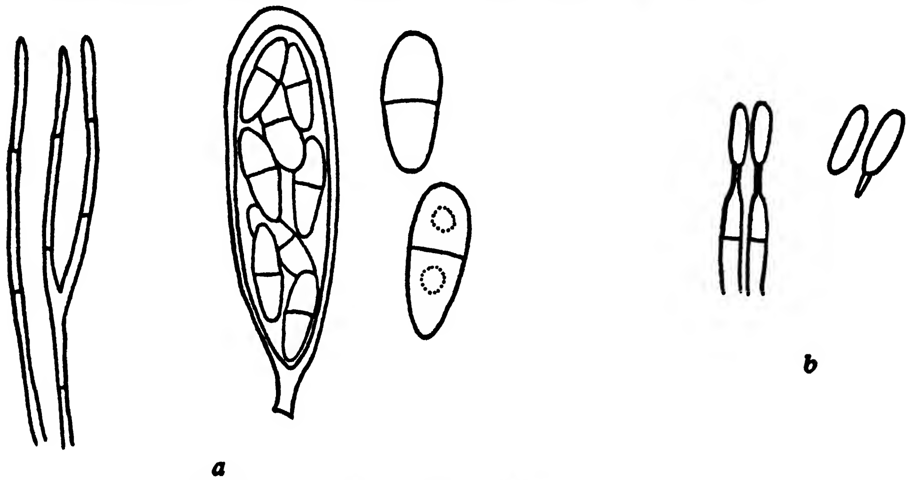


Fig. 1. *a*. Paraphyses, ascus, and ascospores. *b*. Conidiophores and conidia.

Acmaea pelta Eschsch., Land's End, San Francisco, Calif., Bonar. Jenner, Calif., A. R. Grant

Acmaea scabra Gould, Land's End, San Francisco, Calif., Bonar

Acmaea scutum Eschsch., Cypress Point, Carmel Bay, Calif., A. R. Grant
(Determination of species of Acmaea by A. R. Grant)

Mitella polymerus (Sowerby), Cliff House, San Francisco, Calif., Bonar (determined by S. F. Light)

Littorina planaxis Nutt., Point Lobos, Calif., Bonar (det. B. L. Clark)

Tegula funebralis (A. Adams), Point Arena, Mendocino County, Calif., L. R. Mason (det. S. F. Light)

Balanus (Balanus) glandula Darwin, Land's End, San Francisco, Calif., Bonar (det. I. E. Cornwall)

Note by Avery Ransome Grant

Didymella conchae, the fungus described above by Dr. Bonar, appears to be widely spread on the Pacific Coast, attacking certain of the limpets with great frequency, as well as several other molluscs, and even barnacles. The fungus attacks especially the limpets *Acmaea digitalis* and *Acmaea pelta,* uninfected shells of these two species being actually rare. It appears on shells of these species all along the coast from Alaska to San Diego. Its attacks are not restricted to the above-named species of limpets, nor to limpets alone, but are extended to numerous other species, including nearly all the species of the Pacific Coast, and to the other genera.

* Shells of *Patella granularis* L., collected on Cape Peninsula, fifteen miles from Capetown, South Africa, 1935, by Dr. Harold Kirby, bear this same fungus.

The damage caused by this fungus has brought about, in part, some of the difficulties which confront the taxonomist working with the Pacific Coast limpets. In many species of the Acmaeidae, the family of limpets which is most heavily parasitized by this fungus, the external appearance of the shell may be so changed that classification becomes exceedingly difficult. Indeed, the altered appearance of shells after attacks by this fungus gave rise in part to one of the most annoying taxonomic tangles within the genus *Acmaea,* a genus peculiarly fraught with taxonomic difficulties. Eschscholtz, in 1833, named, described, and figured, amongst others, two good species, both from infected specimens. One of the species, *A. digitalis,* is a common species, usually infected, whereas the other, *A. persona,* is not commonly encountered, and is rarely infected. Some thirty years later, P. P. Carpenter revised the Acmaeidae. He thought he had found Eschscholtz' species *A. persona* in the perfect, uninfected shells of what was actually *A. digitalis.* He concluded, naturally, that these shells did not represent a distinct species, and consequently he threw *A. digitalis* into synonymy with *A. persona.* Thus we have a name belonging to one species attached to another, the correct name of which is thrown into synonymy while the species to which the name actually belongs goes nameless, all because of misinterpretations arising from the drastic changes made by this fungus. The fungus is prevalent on many other species, and frequently changes the characters of individuals, usually by elimination of definite characters used in specific identification, such as the anterior concavity of the shell of *A. digitalis,* or the thickening of the normally thin shell of *A. scutum.* Besides changing such specific characters, it replaces the sculpturing and color patterns of the various species by the uniformly rough, irregular, spongy surface, colored ash and brown in indefinite patterns, which results from the attacks of this fungus. The consequent difficulties almost nullify, frequently, the value of keys based on normal characters.

EXPLANATION OF PLATE

EXPLANATION OF PLATE

A. Photomicrograph of surface of *Acmaea digitalis* showing pits in which fruiting bodies develop.

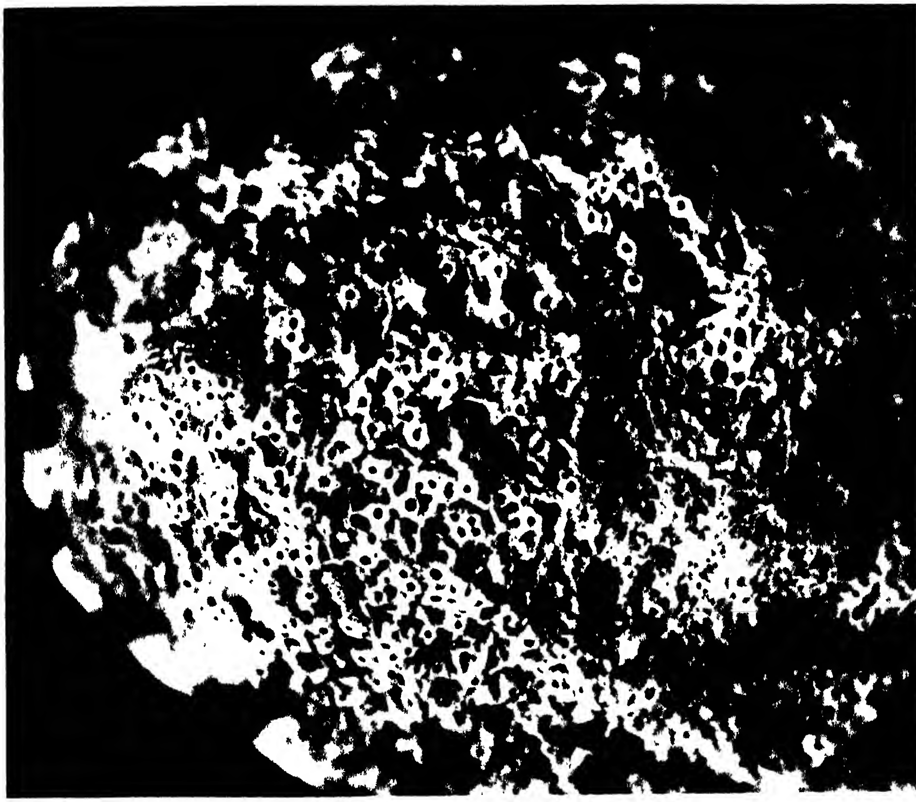
B. Photomicrograph of a section through a shell invaded by the fungus.

a. Matrix of shell in an uninfected area.

b. Area where the fungus has digested the matrix and shows extensively developed mycelium.

c. Fruiting body of fungus in position.

d. Section of an empty pit.



A

B

IRIDOPHYCUS

WITH SPECIAL REFERENCE TO THE SOUTH AMERICAN SPECIES

BY

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AND

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IRIDOPHYCUS, WITH SPECIAL REFERENCE TO THE SOUTH AMERICAN SPECIES

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WILLIAM ALBERT SETCHELL AND NATHANIEL LYON GARDNER

Work on the marine algae of the Pacific Coast of North America, carried on now for many years, is constantly being halted and retarded by the confusions and enigmas of genera which are widespread and seemingly polymorphous. Little can be done with the more localized expression of such a genus until further elucidation of its species in other areas of its occupation has been attempted and some clear outline has been developed out of the general vagueness with which workers are usually confronted. In other words, the genera, particularly of the red algae of the Pacific Coast of North America, must, at least partly, be monographed before any certainty with respect to specific limits, proper specific delimitation, the value of morphological characters, and their possible amplitude of variation may even provisionally be evaluated. Among a number of such genera confronting us in our attempts to improve the knowledge of our Pacific North American red algae, are *Gigartina* and *Iridaea*. We have dealt with *Gigartina* earlier, in a preliminary survey (see Setchell and Gardner, Univ. Calif. Publ. Bot., 17 (no. 10) :225–340, pls. 46–65, 1933). In that publication has been done what seemed possible toward laying a basis—and with many suggestions, both expressed and implied—for future study. We hope, in the present paper, to make the beginnings of a similar attempt at a survey on the genus *Iridea*, but, for reasons to be unfolded later, it seems best to confine the present account largely to the species of South America, which may be thought of as fundamental to the very idea of the constitution of the genus itself.

The name "*Iridea*" was first coined by Stackhouse in 1816 (Ner. Brit., ed. alt., p. ix), for a plant represented on one of his plates (*loc. cit.*, Pl. XVII), where it is designated as "*F. viridis*," but in his list of "genera and species" (*loc. cit.*, p. xii) it is called "*Iridea fluitans* N. 59," which is the plant described farther on in the body of the work (p. 45) as "*LIX. Fucus viridis*" of the Flora Danica. This plant, the "*Fucus viridis*" of one part of the Nereis Britannica (2d ed.) and the "*Iridea fluitans*" of another, Lamouroux had already transferred to his genus *Desmarestia* as *D. viridis* in 1813 (Essai, 25). The name *Iridea* of Stackhouse becomes a synonym and is, in fact, very rarely quoted. It has never appeared, so far as is known to us, in any general work, so that no confusion results from the proposal of Stackhouse.

In 1826 (February), Bory de Saint Vincent (Dict. class. d'hist. nat., 9 :15, 16) revived the name "*Iridea*"[1] for a genus of red algae, based primarily upon the *Delesseria edulis* Lamour. (Essai, 38, 1813), since he places it first in his

[1] The name has been spelled "*Iridea*" and "*Iridaea*," the latter usually adopted, although "*Iridea*" seems to have priority.

account and says that it certainly belongs to this genus, of which, he goes on to say, there are known to us several other beautiful exotic species, and enumerates four (4) of these, each with the final statement that *Halymenia reniformis* Ag., *Fucus Lomation,* and *Delesseria palmata* should also belong to the genus. Bory gives no Latin diagnosis, does not coin a proper binomial for *I. edulis,* and describes the medullary network of such a species as *Iridea cordata* (Turn.) Bory, rather than that of *Fucus edulis,* as characteristic of his *Iridea.* Likewise, Bory directs attention to the earlier *Iridea* of Stackhouse as already relegated to synonymy. In 1826 (in Dumont D'Urville, Flore des Malouines, Mem. de la Soc. Linn. de Paris, 4:594, 1826), Bory also mentions and gives short diagnoses of two (or three?) Falkland Island species already described in the article in the "Dictionnaire classique" and actually makes the binomials *I. cordata* (Turn.) Bory, *I. crispata* Bory, *I. papillosa* Bory, and *I. micans* Bory. From 1827 to 1829 there appeared the text and the atlas of the Botany of the Voyage . . . Coquille (during the years 1822–1825), of which Bory prepared the cryptogamic part (vol. 2(1)) and on pp. 103–114 (issued in Feb., 1828) and in pls. 11–13 bis (issued in 1827) described and illustrated the species of *Iridea* collected by the expedition from the Falkland Islands on the east coast and around to Valparaiso, Chile, on the west coast of South America.

In 1840, Postels and Ruprecht (Illustrationes Algarum) issued their magnificent elephant folio edition on the algae of Russian Asia and America, being chiefly the algae collected by the younger Mertens during the Lütke Expedition of 1826–1829, illustrated by Alexander Postels, and described by Francis J. Ruprecht. In this account, a fairly long list of species of *Iridea* from the northwestern coasts of North America and the adjacent coasts of northeast Asia, in all some 13 species of the north Pacific coasts, are described, 12 of them as new species. This group of species, as well as those of South America, present many problems of identity still far from being solved. We hope to turn our attention to them later.

In 1830, Greville (Alg. Brit., 157–161, pl. 17) adopted the Boryan genus *Iridea* (*"Iridaea"*) as well founded, definitely expressing his understanding that *Fucus edulis* Stackh. is the type of the genus, gave Bory the credit for the binomial *Iridea edulis* (which is not technically correct), included in the genus also the *I. reniformis* (Turn.) Bory (although this binomial is only to be inferred from Bory's statements), and in his "Synopsis generum algarum cum enumeratione specierum cognitarum" of the same work, enumerated (on p. lxi) 10 species of *"Iridea"* to be included under this generic name.

In 1843, Kuetzing enumerated some 6 species of *"Iridaea"* (Phycol. gen., 395, 396), placing *I. cordata* Bory first, but following it immediately with *"I. edulis* Bory." It is Kuetzing's exquisite figure of the microscopic structure of *I. cordata* (Phycol. gen., pl. 77, II, 1843) that tends particularly toward suggesting that he considered this species to be the type of *Iridea.* The structure of the "compound" cystocarp, its delicate but distinct "pericarpium proprium," the reticulum of the medullary filaments (dictyenchyma) and the anticlinal rows of the cortex, are all well shown in Kuetzing's figures.

J. G. Agardh, in 1847 (Kongl. Vet. Akad. Handl., 81–97, pls. i–vii), discusses the South African plants referred to *"Iridaea"* and, following Kuetzing, as he then interprets him, fixes (p. 82) *I. cordata* (Turn.) Bory as the definite type of the genus. It was J. G. Agardh's masterly treatment of the "Cape" species and the comparative clarity of his perceptions of segregation that determined further limitation of the generic content and greater precision in the lines of its demarcation.

It was in 1842 that J. G. Agardh (Alg. Medit., 103, 104) delimited the genus *Gigartina,* but in 1851 (Spec. Alg., 2(1) :246) he discussed the interrelationships of *Iridea, Chondrus,* and *Gigartina,* laying stress on the possession of a *"pericarpium proprium"* by the first and last, and its absence in *Chondrus.* In 1876, J. G. Agardh (Epicrisis Syst. Florid., in Spec. Alg., 3(1) :183 *et seq.*) returned to the differences among the three genera mentioned above and proposed still a fourth genus, *Rhodoglossum,* to be segregated from *Iridea,* as then limited by having its tetrasporangia arranged radially converging. The final distinction between *Iridea* and *Rhodoglossum* was brought out by Kylin (Lunds Univ. Årsskr., n. f., avd. 2, 24(4) :45–51, figs. 25–29, 1928), who described and figured the "accessory" development of the tetrasporangia from the medullary cells in *Iridea* and contrasts the intercalary development of the tetrasporangia from the lower cells of the anticlinal cortical rows in *Rhodoglossom.* In this respect *Iridea* resembles both *Gigartina* (verum!) and *Chondrus,* at least as far as investigated, and all three differ from *Rhodoglossum.*

From the foregoing synopsis of the history of the genus, it may be seen: (1) that Bory's name was antedated by that of Stackhouse; (2) that the genus of Bory was indefinite and general, without a type species being indicated; (3) that, as early as 1830, Greville established *edulis* (Stackh.) Grev. as the type; (4) that Kuetzing, in 1843, but more particularly J. G. Agardh in 1847, established *I. cordata* (Turn.) Bory as the type; and (5) that although Bory finally treated of the genus as was later delimited, this was largely owing to the geographic limitations of the work. From a consideration of all these, it has seemed best, in order to avoid discussion and differences of opinion, not to retain *Iridea,* even as a suggested *"nomen conservandum,"* but to propose a new name to apply to the genus as finally circumscribed by J. G. Agardh in character (but not in exact content) in 1876 (*loc. cit.*) and as segregated from the genus *Rhodoglossum* J. Ag.

Iridophycus Setchell et Gardner

Setchell and Gardner, Proc. Nat. Acad., 22:470, 1936; *Iridea* Bory, Dict. class. d'hist. nat., 9:15, February, 1826 (p.p.); *"Iridaea"* J. G. Agardh, Spec. Alg., 3(1):179, 1876 (pro max. part); Kylin, Lunds Univ. Årsskr., avd. 2, 24(4):50, 51, 1928.

Thallus membranaceo-expansus, e disco aut thallo prostrato oriens, inferne plus minusve brevi-stipitatus, stipitibus simplicibus, in apophysibus expansis; apophysibus levibus aut verrucosis usque ad uno-pluri-dichotomis et nondum lateraliter processubis ornatis, superne in foliis magnopere expansis, tenue membranaceo-usque ad crasse-chartaceis, vulgo sub aqua iridescentibus, superficiebus levibus aut plus minusve verrucosis, spinulosis, aut papillosis;

structura thallorum dictyenchymaticis; cystocarpiis in foliis immersis, aut centralibus, aut subsuperficialibus in superficie una alteraque prominentibus, vulgo nucleos sporarum multos et plus minusve distinctos ostendentibus, tetrasporangiis in soris plus minusve circumscriptis, accessore oriendis, in fronde medio usque ad subcortices positis.

Ut species typica, *Iridaea capensis* Agardhii nominanda est.

Iridophycus is primarily to be thought of as a genus of the eastern Pacific Ocean, because on that ocean's more temperate coasts there are two relatively large aggregates of species. The one along the cooler part of the west coast of South America (extending on down around Fuegia to the Falkland Islands); the other along the cooler part of the west coast of North America (extending around to northeastern Asia). We may possibly think of the genus as primarily austral, in spite of the North American representatives, since the only other occurrences of the genus *Iridophycus* and its related genus *Rhodoglossum* are in South Africa (1 or 2 species of *Iridophycus*) and in the Australio-New Zealand region (2 species of *Iridophycus* and about 6 of *Rhodoglossum*). Only one species of *Rhodoglossum* is, as yet, credited to the South American coasts. *Gigartina* and *Chondrus,* however, occur also in the north Atlantic (see Setchell and Gardner, Univ. Calif. Publ. Bot., 17:256, 1933) as well as in the Pacific regions with *Iridophycus* and *Rhodoglossum.*

In taking up any study for the consideration of the South American species of *Iridophycus,* the treatment of Bory in the Botany of the Voyage Coquille must receive most earnest and careful attention. In this volume and its accompanying Atlas, Bory has given his final opinions, names to be adopted, drawings of the various species, and distribution. In the first place, he discusses the general nature of the genus *Iridea* and, in résumé, gives a list of the species, or probable species, of this genus, not collected during the voyage. On the voyage were collected specimens which Bory has grouped under four (4) species: *laminarioides, radula, Augustinae,* and *micans,* and he has illustrated the first, third, and fourth species magnificently in the Atlas. It must be borne in mind, however, that Bory named some of these species from Falkland Island material and in his two publications previous to the volume of the Voyage (in the Flore des Malouines of 1826 and in the Dict. class. d'hist. nat., also of 1826) he has proposed specific and other names, some of which he has superseded in his last publication, the Botany of the Voyage Coquille. This supersession raises a number of important questions, with respect to priority of binomials as well as to identities between the species of the Falkland Islands first described and those of the Chilean coasts, described later.

A résumé of Bory's changes seems necessary to clarify the situation of specimens and names: In the Flore des Malouines, Bory has 2 species with a variety, as follows: 25, *I. micans* Bory, 26, *I. undulosa* Bory, and 26 β, *I. papillosa* Bory. The descriptions are most brief. In the Dictionnaire classique he includes among others: *I. crispata,* Concepción, Chile (Lesson); *I. papillosa,* Falklands (Lesson); and *I. micans,* Falklands and Concepción, Chile (D'Urville). Finally, in the Botany of the Voyage Coquille, Bory includes *I. laminarioides* Bory, Concepción, Chile (D'Urville); *I. radula* (C. Ag.)

Bory (including his *I. undulosa β papillosa* of the Flore des Malouines); and *I. Augustinae* Bory (including his *I. undulosa* of the Flore des Malouines as well as his *I. crispata* of the Dictionnaire classique), evidently refounded on plants from Concepción, Chile, collected by D'Urville, but including also plants from the Falklands, collected by Lesson and Gaudichaud.

There are, then, of Bory's naming, the following binomials to be considered:

I. micans Bory	*I. crispata* Bory
I. undulosa Bory	*I. radula* (C. Ag.) Bory
I. papillosa Bory	*I. Augustinae* Bory

either as species or varieties or even as undistinguished synonyms. Through studies in Herb. Bory, which is a part of Herb. Thuret, for which facilities our extreme gratitude is expressed to the authorities of the Laboratoire Cryptogamique of the Museum d'histoire naturelle at Paris, certain conclusions or suggestions have been arrived at which will be given in detail later on. But, before leaving the Bory accounts, it may be well to draw attention to his ideas on treatment, since in certain of these binomials Bory evidently intended to suppress certain of his earlier names and substitute other later, more fitting ones. Bory's final arrangement in the Voyage Coquille report (February, 1828) may be represented as follows:

"13. *Iridaea laminarioides*" Bory, Concepción, Chile, D'Urville.

"14. *Iridaea radula*" (C. Ag.) Bory, Falkland Is., *Lesson* (with respect to Falkland Island plants only and excl. *syn. non Boryana*).

"15. *Iridaea Augustinae*" Bory (type), Concepción, Chile, D'Urville.

"16. *Iridaea micans*" Bory, Falkland Islands, D'Urville.

After Bory, the next communications of importance to us so far as the South American Iridaeas are concerned were those of Hooker (J. D.) and Harvey (W. H.) (London Jour. Bot., 4:262, 1845, Bot. Antarct. Voy. (Fl. Antarct.), I, 1(9):188, 189, March 25, 1845, *ibid,* 2(22):485, 586, January 1, 1847). In the first publication of those quoted, were published two important plants in our inquiry, *Iridaea dichotoma* from the Falkland Islands and *I. micans* Bory *β ciliolata* H. & H. (see pl. 26), from St. Martin's Cove, Cape Horn. In the second, the only species mentioned is *I. radula* (Esp.) Bory, whereas in the third both *I. radula* Bory and *I. cordata* (Turn.) Bory are discussed, together with var. *dichotoma* and var. *ciliolata* of their own proposing or reduction.

Most important additions to South American species of *Iridophycus* came from Kuetzing (Spec. Alg., 726, 1849) in *Iridaea ciliata* Kuetz., from Valparaiso (dried specimen in Herb. Binder), later illustrated by him (Tab. Phyc., 17, pl. 10, 1867); *I. obovata* Kuetz. (Spec. Alg., 728, 1849; see also Tab. Phyc., 17, pl. 9, 1867, sub *I. micans β obovata* Kuetz.) from Cape Horn, collected by Hooker; *I. dentata* Kuetz. (Spec. Alg., 728, 1849; see also Tab. Phyc., 17, pl. 14, 1867) and its var. *minor* Kuetz., from Berkeley Sound, Falkland Islands, from Hooker; and, then, *I. heterococca* Kuetz. (Tab. Phyc.,

17:4, pl. 11, 1867), as well as *I. micrococca* Kuetz. (Tab. Phyc., 17:4, pl. 12*a, b,* 1867) from the Island of Chiloé.

The final addition of species of *Iridaea* to the South American coast came from J. G. Agardh (Lunds Univ. Årsskr., 8:8, 1871 (or 2?), Spec. Alg., 3(1):181, 1876, K. Sv. Vet.-Akad. Handl., 5 (no. 6): pl. 10, 1879) when he described and illustrated *I. membranacea* J. Ag. from Valparaiso on specimens formerly distributed under the name of *Grateloupia Cutleriae* (by W. H. Harvey).

Any study of *Iridaea,* or *Iridophycus* as we have proposed to rename the genus as finally restricted, must and most naturally does begin with these variously confused and confusing species of the cooler South American coasts, starting in the Falkland Islands on the east (or Atlantic) side and, rounding Cape Horn, along the western (or Pacific) coasts up to Valparaiso and perhaps even extending up to the Galápagos Islands (see Farlow, Proc. Am. Acad., 38 (no. 4):94, 1902 (sub *Chondrus canaliculatus*).

Interpreting the species more after the fashion of Kuetzing, much more narrowly than after Bory and particularly less broadly than Hooker and Harvey, there seem to us to be 11 species of *Iridophycus* proper, and 3 species to be referred to *Gigartina* or elsewhere.

It is not our intention, in the present paper, to attempt any thoroughgoing exposition of detail of the morphology of the species of the genus, either megascopic or microscopic, although much has been done in this direction incidental to our studies. Individual details may be noted for certain species where they seem to be important. A few matters, however, seem fundamental to any arrangement, and brief mention should be made of these. The attachment is by a basal disk and, apparently, several such disks may be confluent, although it seems possible, in one species at least, that a single disk (i.e., arising from an individual spore) may give rise to a prostrate thallus and, from this to more than one plant. The longer or shorter stipe is simple, but the apophysis may be simple or it may be, even in the same species, one or more times equally or unequally dichotomous, whereas in *Iridophycus dichotomum* the apophysis is always repeatedly dichotomous. The true stipe may be considered to be cylindrical and thus the stipe portion of the basal part of the species may be longer or shorter, from almost nothing to a number of centimeters in length. In almost every species, however, there is intercalated between the true stipe, or the basal cylindrical part thereof, and the expanded "blade," a flattened, more narrowly or more broadly cuneate structure, a seeming transitional but fairly distinct region which is neither true stipe nor true blade. It may not be forcing the issue to apply to this flattened part of the transition place the designation of "apophysis." The apophysis region is most important in certain species, such as *I. dichotomum, I. crispatum,* and *I. ciliatum,* because of the modifications peculiar to it, and it is noticeable in all the other species, because of its extent, shape, and so forth. It affords critical characters in segregation or combining of species, since, if we may judge from our rather extended study of almost all the species of *Iridophycus,* it is *the* part of the plant showing both general and particular modification.

The final divisions of the frond are the largest and broadest, being expanded and flattened into "blades" and bearing the cystocarps, antheridia, and tetrasporangial sori. The shape as well as the size is variable within considerable limits, both among different species and even among individuals presumably of the same species. Nevertheless, among the South American species, so far as our present imperfect knowledge allows us to judge of it, the general shape and size is usually fairly clearly indicative of the species. General shape, shape of apex and of base, character of margins and surfaces, even color, cystocarps, and sori, assist in delimitation into species. Our knowledge of the constancy or variability in microscopic structure of the blade is still too small to allow us to make any very positive statements but, particularly in connection with that of type specimens, the microscopic structure of the blade has been investigated and taken into account.

Such branching as may be found among the species of *Iridophycus* takes place in the apophysis or blade region. Branching is, as might be expected from the close relationship to *Gigartina,* (1) normally dichotomous or subdichotomous and (2) adventitiously pinnate. There is no such full or complicated expression of branching of either sort as is to be seen in the array of species at present included under the generic name of *Gigartina* (see Setchell and Gardner, Univ. Calif. Publ. Bot., 17 (no. 10) :258–262, 1933), but some characters of *Iridophycus* may best be interpreted, perhaps, as of similar phyletic or possibly dynamic manifestations. The dichotomous method of branching is feebly or very slightly represented in the South American species of *Iridophycus*, reaching its most luxuriant development in *I. dichotomum* and *I. membranaceum.* The "pinnate" method of branching is so slight as to seem, phyletically speaking, vestigial. The dichotomies of *I. membranaceum,* as well as the blades, bear lateral leaflets. Those of *I. dichotomum* bear fairly long subulate-cylindrical lateral fimbriae. The simple apophyses of *I. Augustinae* and *I. ciliata* bear small lateral emergences, which may be present also on the margins and surfaces of the basal part of the blade, or the entire blade may also produce such emergences, or even miniature simple or branched papillae. None of the pinnations, however, bears any type of reproductive organs, thus differing from the species of *Gigartina.*

On the characters thus outlined above, together with some which will appear more plainly in the following presentation, the South American species of *Iridophycus* may be proceeded with. There remains the setting up of various divisions within the genus. For *Iridaea,* as finally limited, J. G. Agardh (Spec. Alg., 3, 1 :180–183, 1876) proposed two sections (or subgenera?) : *Euiridaea* to comprise 7 of his 9 recognized species, having the apophysis more or less evidently canaliculately and spathulately dilated in the young fronds, but variously entire or lacerate in the adult fronds; and *Porphyridaea* to include 2 species whose fronds were variously subdivided above the soon complanate apophysis and subdichotomous or more or less compound through leaflets growing out from the margins. Of the 2 species of *Porphyridaea,* one, *Iridaea membranacea,* is to be retained in *Iridophycus,* but the other, *I. atropurpurea* J. Ag., was later (see J. G. Agardh, Lunds Univ. Årsskr., 21 :31, 1885) re-

ferred by him, and seemingly correctly, to the genus *Gigartina*. Following out the method of J. G. Agardh, it seems best to extend the segregation of the South American species of *Iridophycus* and, while the Agardhian designations are retained, two similar sectional names will be added later in this account.

Iridophycus Setchell and Gardner

Setchell et Gardner, Proc. Nat. Acad., 22:470, 1936; *Iridea* Bory, Dict. class., IX:15, February, 1826 (p.p.); Greville, Alg. Brit., LXI, 157, 158, 1830 (p.p.); J. G. Agardh, Spec. Alg., 3, 1:179, 1876 (non *Iridea* Stackhouse, Ner. Brit., ed. alt., p. ix, 1816).

Sectio I. **Euiridaea** J. G. Agardh

Spec. Alg., 3, 1:180, 1876 (lim. mut.).

Stipe proper, usually short, narrowing above into a longer or shorter apophysis, usually simple or with one or two equal or unequal dichotomies, *but with margins devoid of outgrowths* and the terminal expanded parts of various shapes and degrees of forking. (Type species *I. capense* (J. Ag.) S. and G. Proc. Nat. Acad., 22:470, 1936.)

A. Erect fronds arising singly from a discoid attachment
B. Base of blade cuneate to rounded, but not pronouncedly cordate
C. Margins of blade smoothish, at least not regularly ciliate
D. Apophysis elongated, simple or forked, cucullate, at least when dry

1. **Iridophycus Boryanum** S. et G.

Setchell and Gardner, Proc. Nat. Acad., 22:470, 1936; *Iridaea heterococca* Kuetzing, Tab. Phyc., 17:4, pl. 11, 1867; *Iridaea laminarioides* Bory, in Bot. Voy. Coq., 105 (p.p.), pl. 11, fig. 1*A*, *B*, *C*, 1827; Kuetzing, Tab. Phyc., 17, pl. 8, figs. *c*, *d*, 1867 (et Auctt. aliorum p.p.); *Iridaea cordata* Kuetzing, Tab. Phyc., 17:2, pl. 6, figs. *a*, *b*, 1867 (non *Fucus cordatus* Turn.); *Iridaea laminarioides cornucopiae* J. G. Agardh, Spec. Alg., 2, 1:253, 1851 (non *I. Cornucopiae* P. et R., Ill. Alg., 18, pl. 38*b*, 1840).

In proposing his *Iridaea laminarioides*, Bory de Saint Vincent (*loc. cit.*) states that one needs to see specimens of all ages to avoid making two species, one the younger, the other the older, mature plants, and he describes each state fully and carefully. In his plate (*loc. cit.*, pl. 11) he figures the two stages, the younger in figures 1*A*, *B*, and *C*, the mature in figures *D* and *E*. From Bory's type sheet, containing all the plants drawn, with some additions (23 in all), it is seen that all his young plants are very young, seemingly none showing organs of reproduction, while the mature plant (figured under *D*) is placed on the same sheet, as well as one or two younger of the same type. The plant whose apex is represented by figure *E*, a large plant (3 feet long, according to Bory's text), occupies a sheet by itself and is labeled as of figure *E* in Bory's own hand. It is roughish on the surface (as dried), coarsely ciliate on the margins, and folded several times, but the base is absent. From these characters, as well as from details of internal structure, it seems best to separate the two sets of plants under different specific names and, since the larger, older plants of Bory are the only mature plants seen by Bory, to designate them as the types of his *Iridaea laminarioides* and to assign the younger plants of Bory to the *Iridaea heterococca* of Kuetzing (*loc. cit.*).

The color of herbarium specimens is, of course, unreliable and no notes of the colors of fresh specimens are available. Bory says that the consistency is carnose and thick, becoming transparent (translucent?) and of a light violet tint passing into a green of a greater or less intensity as the plant increases in size. He compares the fronds of the young plants to those of *Ophioglossum*. As the frond dries, he says it becomes corneous and of a deep brownish, blackish red.

The *Iridaea Boryanum* S. and G. has a fairly long (2–6 cm.) basal part, which is made up of a very short, cylindrical stipe (proper) of a few millimeters in length and a flattened but narrow elongated apophysis, widening above before it expands more or less suddenly into the cuneate or broadly cuneate-rounded base of the blade. In dried specimens the apophysis is usually strongly canaliculate, expanded above into a broader or narrower cornucopioid support for the blade (see Bory, Bot. Voy. Coq., pl. 11, figs. 1*A–C*, also Kuetzing, Tab. Phyc., 17, pl. 11 and pl. 8, figs. *c, d*). The blade is from more broadly or narrowly lanceolate to ovate-lanceolate, with base cuneate to rounded, and the apex is broadly to narrowly rounded or obcuneate. The margins are devoid of projections and the surface is not roughened either by superficial outgrowths or by projecting sori or cystocarps. Occasionally the apophysis is forked and the blade also may be once or even twice furcate into fairly broad divisions.

The blade is fairly thick (moderately swollen from the dried condition) and averages about 450μ in thickness. The medulla is of dictyenchyma, a very fine but broad network of slender fibers (about 1.5–2μ thick) with close, small meshes. The cortices are thick (about 75μ), with the anticlinal filaments of 8–10–12 cells each, the inner rounder, almost globular, the outer 3 or 4 elongated and narrowed, the outermost series elongated 3–4 times as long as broad and elongated subulate.

The sori, of accessory tetrasporangia, although originating somewhat nearer to one surface than the other, toward maturity and upon attaining appreciable extension, come to occupy much of the width of the medulla. The cystocarps are fairly large (no mature ones seen), occupy very nearly the center of the medulla, and develop a fairly thick, loose (immature) *pericarpium proprium*, Antheridia have not been seen (or at least definitely recognized as such).

The type specimen of *Iridaea heterococca* Kuetzing was so named by him because of the presence of larger scattered papillae, intermixed with the smaller dots showing on the surface. Kuetzing supposed that the larger bodies contained tetrasporangia whereas the smaller prominent dots contained microspores ("antheridia?"). In his figures (Tab. Phyc., 17, pl. 11), *b* is said to represent (as it does) the tetrasporangia, but Kuetzing says that these are in the larger papillae. We find them, however, in the smaller prominences (of the dried plant) as well. The figure *c*, said to be cut through the smaller prominent dots and as representing microspores, shows colonies of an infesting *Myxophycea*, apparently a *Hyella* and closely related to, possibly identical with, *H. infestans* M. A. Howe (Mar. Alg. Peru, 14–16, figs. 4–8). This seems to be a frequent endophyte in the *Iridaea heterococca*, but is by no means always

present. The name *Iridaea heterococca* Kuetzing, therefore, being based upon a monstrosity, or better, upon characters derived from two more or less discordant elements, especially as these characters were erroneously supposed to form part of the same individual, viz., an *Iridaea* infested by a *Hyella,* is to be rejected under our present rules of nomenclature (see Int. Rules Nomencl., ed. 3, articles 64 and 65, 1935) ; hence the rejection of Kuetzing's designation in favor of the new specific name *"Boryanum."*

Iridophycus Boryanum seems confined to the coast of Chile. The following collections have been studied: Concepción, Chile, leg. D'Urville (juvenile types in Herb. Bory in Herb. Mus. Paris!), near Valparaiso, Chile, leg. U. S. Expl. Expn. (Wilkes), 1838–1842 (in U. S. Nat. Herb.! and Herb. N. Y. Bot. Garden!).

DD. Apophysis comparatively short, flat (even when dry)
E. Blade thicker, carnose-cartilaginous

2. **Iridophycus obovatum** (Kuetz.) S. et G.

Plate 23

Setchell and Gardner, Proc. Nat. Acad., 22:470, 1936; *Iridaea obovata* Kuetzing, Spec. Alg., 728, 1849; J. G. Agardh, Spec. Alg., 3, 1:183, 1876; De Toni, Syll. Alg., 4, 1:192, 1897; *Iridaea micans β obovata* Kuetzing, Tab. Phyc., 17:3, pl. 9, 1867.

Kuetzing (Spec. Alg., 728, 1849) describes his species as having a very broad obovate "phyllome," abruptly attenuated at the base into a short teretish stipe, with cystocarps remotely scattered, of a membranaceo-cartilaginous consistency, a purple color, and perenchymatous (dictyenchymatous medulla) structure. The type specimen came from Cape Horn and was donated by J. D. Hooker. The figures (Tab. Phyc., 17, pl. 9, 1867) of his *I micans β obovata* show a plant consistent with his description but departing in minor detail from each of the two specimens at present preserved in his herbarium (at Leyden!). The larger of the two specimens on the sheet, labeled as being from Cape Horn, is 22 cm. high and 16.5 cm. broad (above the middle). It is of a yellowish pink color, and, although thin, is cartilaginous in consistency. It shows a few scattered tubercles (cystocarps?) on the surface. The whole impression is of a somewhat obliquely curved frond. The smaller specimen, seemingly sterile, has the same general shape, color, and consistency, is 9.5 cm. high, 5.5 cm. wide (above the middle), is decidedly obliquely unequal on the two margins, and is labeled as having been collected "on rocks, Berkeley Sound, Falkland Islands, J. Hook."

The two specimens in Herb. Kuetzing, together with Kuetzing's description and habit figure, convey the impression of a plant very different from those of *Iridaea micans* Bory with respect to form and color. Another plant accessible to us, and from which detailed studies have been made, is one collected by Robert N. Rudmose Brown, on the Scottish National Antarctic Expedition at Cape Pembroke, East Falkland Islands, in 1903. This specimen, although imperfect at the base and lacerated (by the waves?), is in Herb. Univ. Calif. (no. 435445) and was received from the Herb. Brit. Mus. It seems clearly to

belong with the two specimens of Kuetzing and to be properly referred to the *Iridaea obovata* Kuetzing.

Cross sections of the Rudmose Brown specimen (when well swollen out, but before becoming noticeably diffluent) are about 375μ in diameter in the sterile parts, the central tissue layer (medulla) being much swollen in the region of the cystocarps, so that the total diameter is increased to 500–625μ. The medulla occupies about two thirds of the thickness of the unmodified form, each of the two cortices occupying about one-sixth. The dictyenchyma of the medulla is very regular and moderately meshed, of slender, anastomosing filaments about 3–4μ in diameter. The inner cortex is made up of a stellate dictyenchyma-like tissue, and the anticlinal rows are 7–8 celled, the inner rounded, passing inwardly to stellate, whereas the outer, closely packed, are rounded-oblong to short-oblong cylindrical, with the outermost slightly longer than broad with its outer end very slightly narrowed into the blunt, rounded apex.

Cystocarps only are known in this species, whose reference, consequently, to *Iridophycus,* is based on general resemblance. The cystocarps are very nearly central in the tissues, and those observed (none really old, but some seeming with mature spores) range from 275–625μ in horizontal diameter. There is a fairly (up to about 35μ) thick *pericarpium proprium,* and the general shape is depressed spherical and of regular outline. The figure given by Kuetzing (pl. 9, fig. *b*) shows a good general view, only the number of cells in the anticlinal rows and a few other such details being outlined without precision.

As mentioned earlier, the species is noted from "Cape Horn" (type specimen in Herb. Kuetzing at Leyden!), undoubtedly collected by the British Antarctic Expedition of 1839–1843; from Berkeley Sound in the Falkland Islands, and preserved in Herb. Kuetzing, and from Cape Pembroke, East Falkland Islands, collected in 1903 by Robert Rudmose Brown of the Scottish National Antarctic Expedition (Herb. Univ. Calif., no. 435445). Thus far, it is not known from the strictly Pacific coasts of South America, but it seems desirable also to refer to *Iridophycus obovatum* a series of specimens collected by Skottsberg on the coasts of Graham's Land during the Swedish South Polar Expedition of 1901–1903. These specimens are all young, but some of them show early cystocarpic development. Some three or four specimens from Cape Roquemaurel of Graham's Land (Station 7) have been studied in Herb. Stockholm!, Herb. Uppsala!, and Herb. Univ. Calif.! (see pl. 23, below) (sub "*Iridaea cordata*").

EE. Blade thin, chartaceous

3. **Iridophycus micrococcum** (Kuetz.) S. et G.

Setchell and Gardner, Proc. Nat. Acad., 22:470, 1936; *Iridaea micrococca,* Tab. Phyc., 17:4, pl. 12, figs. *a, b,* 1867; De Toni, Syll. Alg., 4, 1:196, 1897.

There are two specimens on the type sheet in Herb. Kuetzing at Leyden, the lower one narrower (about 22 × 6 cm.), the upper one broader (about 20 × 17.5 cm.), but neither showing a base. The lower one is the specimen

outlined by Kuetzing on his plate (*loc. cit.*) although the figure ("*a*") is somewhat smaller (about two-thirds diam. in reduction) than the herbarium specimen. They were collected on the Island of Chiloé, Chile.

One other fragment is available (Herb. U. S. Nat. Mus.) and is significant of the size possibly attained by the species. This fragment was collected at San Carlos, Chiloé (the type locality), has the texture, color, and sori of the species, but although incomplete, lacking both base and apex, measures approximately 21 cm. long by 15 cm. in the broadest part of the width. The plant from which it came must have been at least 30 cm. long.

Iridophycus micrococcum is to be distinguished from all other species assigned to the *Euiridaea* section from South America by its lively pinkish tint, by its seeming thinness (when dry) and its delicacy of texture (chartaceous when dry). Certain delicate specimens of *Iridophycus undulosum* closely approximate it, but these show a greater or less number of emergences on the apophysis (*Gigartiridaea* section). Unfortunately no complete bases are present in any of the specimens here referred to *I. micrococcum,* but the seeming apophysis is devoid of emergences. In structure, the type specimen shows a thickness of frond up to 500–600μ when fully swollen out. Its medulla, however, accounts for more than 420μ of this and is composed of intercellular jelly through which runs a very loose network of filaments of about 5–6μ in thickness, with finely granular contents. This medullary jelly shrinks to a small proportion of its thickness on drying. The cortical layers are thin, about 25–30μ thick, of rather loosely packed short anticlinal rows of 3–8 cells each. The cells of the anticlinal rows are rounded to oblong, the outermost more or less decidedly swollen (or enlarged slightly) at their outer ends.

The sori are thickly scattered, are well immersed in the medulla, but nearer to one surface or the other, vary somewhat in size, about 250–360μ in a direction parallel to the surface and 125–200μ at right angles to it. The tetrasporangia are accessory in origin. No cystocarps have been seen.

Iridophycus micrococcum seems to be a very distinct and readily recognized species. So far, its known range is very limited. The types and the specimen in U. S. National Herb. came from the Island of Chiloé on the west coast of South America.

CC. Margins of adult blade rough to ciliate

4. **Iridophycus laminarioides** (Bory) S. et G.

Setchell and Gardner, Proc. Nat. Acad., 22:470, 1936; *Iridaea laminarioides* Bory, Bot. Voy. Coq., 105 (p.p.), pl. 11, figs. 1*D* and *E*, 1827 (only with respect to "adult state"); Auctt. aliorum p.p. minori. *Iridaea laminarioides* var. *β laminarioides* J. G. Agardh, Spec. Alg., 2, 1:253, 1851.

Iridaea laminarioides Bory was founded on two sets of plants. Of the one, considered by Bory (*loc. cit.,* 105) "l'état jeunesse" and represented by his figures *A–C* (*loc. cit.,* pl. 11, fig. 1), many of the plants abort before obtaining their full development. The other set, those acquiring greater proportions, elongate into blades of 1–3 feet in length, a width of 2–6 inches, become much thicker, flabby, appearing at first entire in outline, narrowed toward each

extremity, obtuse at the apex, cuneate toward the base, at times divided into two or three more short or lanceolate lobes. The color is a very beautiful dark green, which passes into a brownish dark red when the plant decomposes, but which, also, is preserved at times in the lifelike transparence of herbarium specimens. The habit of the type (!) of Bory is well represented in his figure *D* (*loc. cit.*, pl. 11, fig. 1), and the ciliate margins of mature individuals are represented by Bory's figure *E* (*loc. cit.*). The fructification shows as innumerable purplish spots. The plant is mucose, adheres well to paper, but in spite of its mucosity is rather rough to the touch (when dried) because of the reproductive "gongyles." So far as indicated, both the "juvenile state" of Bory (see *Iridophycus Boryanum,* discussed earlier in this account) and the mature state were both collected at Concepción by D'Urville.

The two sets of plants referred by Bory to his *Iridaea laminarioides* may possibly, as he suspected, belong to one and the same species. In view, however, of the fact that Bory apparently never saw fruiting plants corresponding exactly to the habit of his "juvenile" specimens and also in view of the fact that such plants have been collected since that time and are available (see sub *Iridophycus Boryanum* S. et G.), emphasis may be laid upon certain differences between the "juvenile" and "mature" plants of Bory, in detail sufficient perhaps to segregate the two as types of different species. If so, it seems most desirable to retain, as has been indicated earlier, the binomial for what Bory considered to be the mature, characteristic plants, and to segregate the species represented by the "juvenile" plant under another binomial, *Iridophycus Boryanum* Setchell et Gardner, which has been done. Furthermore, there is, on the lower right-hand corner of the type sheet in Herb. Bory, what seems to be two juvenile states, very different from the 20 young plants in the upper left-hand corner of the same sheet, which, both from their appearance as well as from their placing on the sheet, differ from the other juvenile specimens on the sheet, and again agree reasonably, in their essential characters, with the large "adult" plant (Bory's pl. 11, fig. 1*D*) on the same sheet. This strengthens the general conclusion that the *Iridaea laminarioides* Bory is made up of two distinct species, which differ from one another sufficiently in both the juvenile and the adult stages to be segregated under different binomials.

The description of the species, as limited to the adult state of Bory, has been described above in a free transliteration from Bory's statements. The greater size attained by the true *laminarioides,* the very long, flat (even when dry), and narrowly cuneate apophysis with its tendency to fork, the cuneate base of the blade, not to be distinguished from the upper part of the apophysis, the rather thicker, softer, character of the blade, and the tendency of the margins of the blade to depart from smooth and even to become densely ciliate, distinguish *Iridophycus laminarioides* (as limited) from *I. Boryanum.* Unfortunately, there are no specimens to be referred with certainty to true *I. laminarioides* other than the type specimens in Herb. Bory. Of these there are four, three on the main type sheet, one of which, on the right hand of the sheet, is the plant "D" (of Bory's pl. 11, fig. 1*D*), the other two, small, young

plants, about 5 to 23 cm. high, on the lower right corner of the sheet, and the plant "E" (of Bory's pl. 11, fig. 1), a much doubled blade, somewhat disintegrated, whose upper left-hand lobe only was represented by Bory.

The structure of the blades of these specimens approaches that of the blades of *I. Boryanum,* but there are minor differences, probably constant. The width of a section of the blade fully swollen out is from about 500μ in the "D" plant to about 650–700μ in the much more mature "E" plant. The broad medullary layer (up to 625μ) is mainly intercellular jelly, but fine filaments, about 3μ in diameter, traverse it in an irregular, loose-meshed reticulum (dictyenchyma). The mature cortices (of "E") are about 50μ thick, the inner cells not conspicuously larger than those of the closely packed moniliform anticlinal rows, whose cells are slightly longer than broad and whose terminal cells are elongated (up to 4 or 5 times the diameter), with blunt, suddenly rounded tips. Plant "E" shows sori, well below the cortex on each side but not extending inward very far beyond the center line of the section. The sori are somewhat irregular in outline, not much flattened, an average sorus measuring about 375μ in horizontal diameter by 275–300μ in vertical diameter. Plant "D" seems immature, possibly but not certainly antheridial. It is thinner, the margins are only remotely and minutely ciliate, the medullary reticulum is more regular, and the terminal cells of the anticlinal filaments of the cortices less elongated, often even globular.

The only certain locality for *Iridophycus laminarioides* is the type locality on the Island of Chiloé off the coast of Chile, where it was collected by Dumont D'Urville.

BB. Base of the blade pronouncedly cordate

5. **Iridophycus micans** (Bory) S. et G.

Setchell and Gardner, Proc. Nat. Acad., 22:470, 1936; *Iridaea micans* Bory *in* D'Urville, Fl. des Malouines, 594, 1826, Dict. class. d'hist. nat., 9:16, 1826, Bot. Voy. Coq., 110, pl. 13, 13 bis, 1827; Kuetzing, Spec. Alg., 726, 1849 (p.p.); J. G. Agardh, Spec. Alg., 3, 1:181, 1876 (p.p.); et Auctt. aliorum maxime p.p.; *Iridaea radula* Hooker and Harvey *in* Hooker, J. D., Bot. Antarct. Voy. (Fl. Antarct.), I, 1(9):189, 1845 (p.p.); *Iridaea cordata* Hooker and Harvey, *loc. cit.,* 2:486, 1845 (p.p.).

Although Bory's first drafts of the description of his *Iridaea micans* was published in D'Urville's Flore des Malouines and in the Dictionnaire classique, the complete account with proper illustration must be looked for in the Botany of the Voyage Coquille (*loc. cit.*). Bory's conception of the species is that of a fairly ample, distinctly broader than long, cordate expansion with distinct "stipe" and rounded apex, conspicuously iridescent when submerged. This idea is well shown on his plate 13 and it is this figure which, probably correctly, has dominated all subsequent ideas of *I. micans.* In Herb. Bory is preserved the type sheet of plate 13, properly inscribed and documented by Bory (!) as having been collected by D'Urville in the Falkland Islands in "1826." The plate *seems* to show a group of three fronds, at least three *attached* stipes are shown below, but, also, they are made to bear, *collectively,* a single blade. The specimen in Herb. Bory matches the plate very closely, but shows disintegration effects (some deliquescence) in preparation. It seems to have

a single blade with three stipes. One of the stipes has part of a small basal disk, whereas the other two show nothing of it. The impression left with one who examines the specimen (see, however, Bory's belief given below) is that there is probably only one specimen, whose stipe and apophysis have been split longitudinally into 3 pieces in the process of resoaking (alluded to by Bory, on p. 111), and that Bory, in making the drawing for plate 13, took the liberty of representing each of these three artificial segments as natural and as attached. The blade is seemingly antheridial, very thin when dry, but swelling up to double or more when wet, and with margins undulate and showing remote, very slightly projecting callosities. On another sheet in Herb. Bory are four fairly large fragments containing (among others) the two imperfect specimens represented on plate 13 bis, *A* and *B*. While *A* gives one an entirely different impression from that obtained from the more complete antheridial plant represented on plate 13, it seems truly cordate, although lacking a stipe, but less tending toward orbicular. It is thicker and more cartilaginous (when dry) and shows cystocarps. It seems proper to agree with Bory in assigning *A* to the life cycle of *Iridaea micans.*

Iridaea micans Bory has been compared to the northeast Pacific *Iridaea cordata* (Turn.) Bory and the combined nomenclature is so much confused that it seems undesirable to attempt to unravel it. Unfortunately it has not been possible, thus far, to detect the type specimen of *Fucus cordatus* Turn., so that all that can be compared is Turner's description and plate (Fuci, 2:118, pl. 116, 1809) of the cystocarpic plant. The two species are something of the same habit, but the apophysis in *cordata* is broader, tending to be channeled when dry (possibly more cornucopioid), and the blade seems less profoundly cordate at the base. It seems best to keep the two, certainly antipodally, widely separated, species separate, at least for the present, and particularly until the tetrasporic plant of *I. cordata* is definitely recognized. The stipe in *I. micans* is described by Bory (Bot. Voy. Coq., p. 110) as short and described later (*loc. cit.*, p. 111) as being one inch long, slightly canaliculate, and a lively violet in color. Bory also speaks of the three stipes of his figure (on pl. 13, and mentioned above) as coming from the base of a cordate blade, as if several blades may have fused, but it seems, as indicated earlier, to be rather one stipe (plus the apophysis) split into three in the process of soaking out that he mentions. The apophysis is narrowly cuneate, about 2 cm. (approx. 1 in.) long, and canaliculate in drying, also the apophysis with respect to margins and surface, is devoid of emergences, as is also the surface of the blades. The margins of the blades, however, are undulate, somewhat thickened, with small callosities. The bases of well-developed blades are strongly cordate.

Iridophycus micans is represented by only two types of fertile fronds, the cystocarpic and the antheridial. The cross sections of the blades agree reasonably well in structure, with such differences as seem usually associated with different types of fertile fronds in other species of *Iridophycus*. The blade of the presumably antheridial plant of Bory's plate 13 shows a section approximately 185μ in thickness, with the medulla occupying about one-half or a little more, of the thickness. The medullary layer is made up, in large part, of

intercellular jelly, through which run slender filaments (1–2μ thick) nearly parallel, with occasional cross-connecting strands to make a reticulum, at times more, but also at times less, perfect. The outer filaments of the medulla pass over on both sides into the delicate reticulum of the inner parts of the cortices, only very slightly larger than those of somewhat more compact anticlinal rows. The cells of the rows of the cortex are arranged rather loosely, are approximately globular, depressed or compressed, and number about 6–8 to a complete row. The rows are dichotomous to the cuticular layer, the outermost cells are globular and about 4–5μ in diameter. The antheridia (?) form an outermost layer of colorless, rounded or ellipsoidal cells, budding off in pairs from the outermost cortical cells. They occur in large and indefinite patches on the frond, perhaps covering the entire surface of the blade.

The structure of the cystocarpic frond of the plant represented by Bory as figure *A* on plate 13 bis, resembles that of the antheridial blade of the plant of plate 13, in general, but is, naturally, thicker, varying from approximately 525μ, in sterile areas, to over 625μ in the region of a fairly mature cystocarp. The medulla occupies about three-fifths of the thickness with very delicate filaments, forming a loose but fairly regular reticulum with elongated meshes, in the medullary jelly. The cortices, although slightly more compact than those of the antheridial plant, are lax as compared with those of most species of *Iridophycus*. There are about 8 cells in the series from inner to outer ends of the anticlinal rows, the inner larger (by about twice) than the outer, with the intermediate approximately globular cells diminishing gradually from within outward. The terminal cells of the rows are appressed globular, about 3–4μ long. The cystocarps are nearer one surface than the other, causing the nearest surface of the frond to form almost a papilla above them on that side, whereas the opposite surface is broadly bulging. Bory (Bot. Voy. Coq., p. 113) says that the "gongyles" become as large as a mustard seed, making the surface of the plant rugose and rough like shagreen. The largest cystocarp examined in section measured 875μ in its greatest diameter, but this measurement is probably surpassed by others, since the cystocarps vary in diameter (according to age?). The cystocarp is surrounded by a fairly dense *pericarpium proprium* of concentric filaments, about 60–65μ thick.

The blade of the plant represented by Bory in figure *B* of plate 13 bis, however, presents a structure sufficiently different to compel us to hesitate to assign it also under *Iridaea micans* as Bory has done, since it seems dubious with respect to its true relations. It has no base, but suggests a possibility. The blade is not clearly cordate at the base, but rather a ruffled ciliated blade torn across. In the latter character it seems to agree better with the "mature" plant of Bory's plate 11, figure 1*E*, referred to *I. laminarioides* as limited by us. The sections show cystocarps, with large spores and a thick, dense pericarp, a medulla with a reticulum of rather coarse filaments with fully granular contents, and cortices in which the inner cells are rounded and much larger than the closely packed almost cylindrical anticlinal rows, whose cells are elongated with the outermost longer than broad, but bluntly conical. In all these characters, the sections, as well as the fragment of the frond from which

they came, agree better with that of the two plants of Bory selected earlier in this account to bear the name of *Iridaea laminarioides* Bory than with plants of plate 13 and *A* and *B* of plate 13 bis of Bory, which it seems reasonable to accept as fundamental to Bory's conception of *Iridaea micans*. Bory also says of the "old" fragments, represented under *B* and *C* of his plate 13 bis, that they reach a length of 2 feet, and he, himself (*loc. cit.*, p. 113), compares them to the plant of *I. laminarioides* of which he has represented parts on his plate 11, figure 1*E*. The fragments retained in his herbarium on the two sheets seem too close to be separated specifically.

Bory evidently had (or at least preserved) no plants of his *Iridaea micans* showing tetrasporangial sori. Skottsberg (K. Sv. Vet.-Akad. Handl., 63, 8:7, 1923), however, has mentioned (*sub* his *Iridaea cordata*) "typical *micans*," not only cystocarpic, but also tetrasporic, from South Patagonia and from South Georgia. These plants are not, at this time, accessible to us, and Skottsberg gives no details concerning the tetrasporangia. Presumably they are accessory, since in the same paper (*loc. cit.*, p. 8, fig. 1*b*) he distinguishes his *I. macrodonta* from South Georgia as having the intercalary (or the *Rhodoglossum* type of) sori. Later on, further reference will be made to this species, which occurs also at the Falkland Islands (see *"Iridaea cordata"* Cotton, Jour. Linn. Soc., 43:176, 1915, p.p.) and which, because of its general resemblance, has been confused with *I. micans* Bory.

Iridophycus micans (Bory) S. et G. seems to be a characteristic species of the Falkland Islands and presumably extends to South Patagonia, Fuegia, and to South Georgia. It has not been substantiated satisfactorily as yet on the coasts of Chile, nor on the Antarctic continent, nor on the Crozets or other Antarctic islands to the south of the Indian Ocean. From *Iridaea cordata* (Turn.) Bory of the Pacific Coast of North America, so far as that species may be reasonably identified (type specimen not known), it differs in habit and in its probably more delicate structure.

AA. Erect fronds arising successively from a common prostrate, attached thallus

6. **Iridophycus caespitipes** S. et G.

Plate 24

Setchell and Gardner, Proc. Nat. Acad., 22:470, 1936; *Iridaea cordata* Cotton, Jour. Linn. Soc., 43:176, 177, 1915, p.p. (non *Fucus cordatus* Turner).

Type specimen, cystocarpic! Magdalene Islands, Straits of Magellan, Hassler Expedition (no. 32066 in Herb. William Randolph Taylor); imperfect tetrasporic specimen, Falkland Islands, Mrs. Elinor Vallentin (Herb. Kew! and Herb. Univ. Calif., no. 207076).

Iridophycus caespitipes, as represented by the type collected by the Hassler Expedition at the Magdalene Islands in the Strait of Magellan (no. 2066, Herb. William Randolph Taylor), is unique among the species of this genus, in that a basal crust ("Sohle") is developed to such a degree as to be not only

conspicuous, but also extensive and continuous (or at least prolonged) in its activity. The erect fronds seem to succeed one another, thickly placed, new ones appearing around (and, or among?) the older ones so that all stages from minute young fronds not yet differentiated into stipe, apophysis, and blade, up to fully formed fruiting fronds are represented. The habit of the erect frond reminds one of that of *I. micans,* but the extremely short-cylindrical stipe passes, at once, into a thick, flattened apophysis, which is smooth and destitute of emergences. At its apex, the somewhat broadened apophysis passes abruptly into a cuneate blade, which becomes finally reniform cordate. The substance of the whole plant is thickish and tough (when dry), of a wine red to brownish red, at least in herbarium specimens. The type collections are cystocarpic, but there may be associated with it, and with confidence with respect to its specific identity, a larger and tetrasporic fragment from the Falkland Islands, collected by Mrs. Elinor Vallentin, one of two fragments sent by Dr. A. D. Cotton to one of us (W.A.S.) in 1914 and alluded to by him in his 1915 paper (see Cotton, *loc. cit.*). This specimen lacks any complete basal part, but in color, texture, and microscopic structure is in too exact an agreement with the cystocarpic type plants to allow of much doubt about its close relationship.

The horizontal, adnate crust is only moderately thick, but the type specimen has been cut away from the rock, so that its actual thickness nowhere appears complete. It seems possibly to reach a thickness of not more than a millimeter. The structure is very dense, with the segments of the filaments closely packed together and with thick and very dense walls. The cortex is also dense and the outermost cells of the anticlinal rows of cells are covered with a thick and dense "cuticula." Cross sections of the adult blade are 375–500μ thick, even up to 750μ in the region of the cystocarps or the sori. The medulla occupies about two-thirds of the thickness, with the medullary filaments, although varying somewhat in coarseness, usually have short, rather stout segments, averaging from about 5μ to 12μ in thickness and densely gorged with finely granular contents. Both the cortices and the medullary filaments seem very distinctive, as compared with those of the other South American species studied. The cortices are wide, about 60–65μ broad, and consist of 10–12 (plus in some instances) series of cells, the innermost larger and rounded, the outer 8–10 in closely packed anticlinal rows, the individual cells elongated and narrow, long ellipsoidal to almost rod-shaped (outermost 1–2 layers). It was the striking correspondence of the structure of the blade of the Falkland Islands plant with that of the type specimen that induced the placing of the two together.

The cystocarps are central in the medulla and with a well-developed *pericarpium proprium.* The sori are also central in the medulla and rather diffuse in their spread.

Thus far, the distribution of *Iridophycus caespitipes* seems limited to the Falklands and adjacent Fuegia. It is to be hoped that other specimens may be found to make broader our knowledge of this most interesting and seemingly distinct species.

Sectio II. **Porphyridaea** J. G. Agardh

Spec. Alg., 3, 1:181, 1876; De Toni, Syll. Alg., 3, 1:188, 1897; Setchell and Gardner, Proc. Nat. Acad., 22:471, 1936.

Apophysis elongated, complanate, flat, linear, simple or once (+ ?) dichotomous, with margins naked or emitting sparse leaflets; blades simple or furcate, elongated, narrow, usually pinnate, with marginal and occasionally superficial leaflets; of thin, membranaceous, *Porphyra*-like texture; cystocarps and sori (accessory in origin) of *Iridophycus.*

7. **Iridophycus membranaceum** (J. Ag.) S. et G.

Setchell and Gardner, Proc. Nat. Acad., 72:471, 1936; *Iridaea membranacea* J. G. Agardh, Lunds Univ. Arsskr., 8:8, 1872, Spec. Alg., 3, 1:181, 1876, K. Sv. Vet.-Akad. Handl., 15, 6: pl. 10, 1879; De Toni, Syll. Alg., 4, 1:188, 1879.

William Henry Harvey, in 1856, collected at Valparaiso, Chile, specimens of a thin, red, much dissected plant, which were distributed from his duplicates under the name of *Grateloupia Cutleriae* (non *Iridaea Cutleriae* Bind.), some forms of which the cystocarpic plant superficially resembles. In 1872, J. G. Agardh (*loc. cit.*) recognized the close relation of this plant to *Iridaea* and christened it *Iridaea membranacea.* Although he does not mention it, his type specimen (no. 23916, Herb. Ag.) is noted "ded. Harvey." With this specimen, J. G. Agardh later associated, in his herbarium, certain other specimens from Chile and from the coast of California, which have no immediate relationship (being *Euiridaea* or *Rhodoglossum* types) with the Valparaiso specimen. Not only did J. G. Agardh erect the Harvey plant into a new species, but he also created for it (in 1876, p. 181) a special section, *Porphyridaea,* in which it seems convenient to follow him. Agardh also included in his section *Porphyridaea, Iridaea atropurpurea* J. Ag., from New Zealand, with respect to the tetrasporic plant, but later, when the cystocarpic plant became known, this species was, properly, transferred to the genus *Gigartina,* leaving *I. membranacea* as the sole member of *Porphyridea.*

J. G. Agardh had, apparently, both cystocarpic and tetrasporic individuals. The plant whose habit is depicted (Pl. X, fig. 1) is tetrasporic. The cystocarpic plant is represented only in a transverse section of the blade (Pl. X, fig. 4). Although the sections are conventionalized (or diagrammatic), one may surmise that a *pericarpium proprium* is present, but thin. Plants in Herb. Univ. Calif. (sheet no. 77095), obtained many years since from Harvey's duplicates, are all tetrasporic. Transverse sections of these range (when properly swollen) from 250 to 500μ in thickness, the larger thickness resulting from the expansion of the fully developed sorus. The medulla occupies somewhat more than three-fourths of the sterile part, transversed by thin filaments (1.5–2μ diam.) in a loose reticulum with elongated meshes. The cortices are made up of 5–6-celled anticlinal rows, without any sudden transition from the slightly larger, more loosely placed inner cells to those of the crowded outer parts of the filaments. All the cells are strongly depressed spherical, the outermost differing little in shape and size from those within them. The sori are fairly thickly scattered, arise in the central part of the medulla by accessory processes from the medullary filaments, increase in size until they fill the medulla from

cortex to cortex, and increase the thickness of the blade to about twice its original dimension. Some larger ones, seen in the sections, measure about 750μ (hor. diam.) by 325μ. In surface view of a mature frond, some sori are 1.5 mm. parallel to the length of the blade. They have not been seen to occur on the apophysis, but do occur on the lateral leaflets of the blade.

Iridophycus membranaceum is known to us only from the original collection from Valparaiso, collected by W. H. Harvey in 1856.

Sectio III. **Chondriridaea** S. et G.

Setchell and Gardner, Proc. Nat. Acad., 22:471, 1936.

The section *Chondriridaea* was instituted to receive a *Chondrus*-like species, the *Iridaea dichotoma* Hook. f. et Harv. It is to be distinguished from all other species of *Iridophycus* by its fairly regular and frequent, successive dichotomies and the production of lateral, marginal fimbriae and leaflets. This habit leads to an appearance more of that of a *Chondrus* than of any other strictly *Iridophycus* species, but is found also in *Rhodoglossum affine* (Harv.) Kylin (*Chondrus affine* Harv.) of the coast of California. Only 1 species, *I. dichotomum,* is referred to this section.

8. **Iridophycus dichotomum** (Hook. fil. et Harv.) S. et G.

Setchell and Gardner, Proc. Nat. Acad., 22:471, 1936; *Iridaea dichotoma* Hooker, J. D., and W. H. Harvey, Lond. Jour. Bot., 4:262, 1845; Kuetzing, Spec. Alg., 728, 1849, Tab. Phyc., 17:5, pl. 13, figs. *c, d,* 1867; J. G. Agardh, Spec. Alg., 3, 1:183, 1876; Skottsberg, K. Sv. Vet.-Akad. Handl., 63, 8:8, 1923; *Iridaea cordata* var. *dichotoma* J. D. Hooker, Bot. Antarct. Voy. (Fl. Antarct.), II:485, 1847; *Iridaea dentata* and var. *minor* Kuetzing, Spec. Alg., 728, 1849, Tab. Phyc., 17:5, pl. 14, 1867; De Toni, Syll. Alg., 4, 1:188, 1897 (sub *I. Augustinae*).

Unfortunately, *Iridophycus dichotomum* is known to us only in the cystocarpic plant, and we find no mention of the tetrasporic generation in any of the literature. The cystocarp, however, is immersed in the frond, is characteristically the "compound" cystocarp of the *Gigartinaceae,* and has a well-developed *pericarpium proprium* (see Kuetzing, Tab. Phyc., 17, pl. 14, fig. *b,* 1867). The absence of knowledge of the character of the sori, leaves, of course, the exact nature of the species uncertain, but nevertheless it may with some confidence be placed in *Iridophycus.* It is certainly not a *Chondrus,* although it might (?) belong to *Rhodoglossum.*

The type locality of *Iridaea dichotoma* H. f. et H. is the Falkland Islands, and Hooker and Harvey included in it the specimens with more ample, denticulate to grossly dentate margins, afterward segregated by Kuetzing under *Iridaea dentata.* The exact locality (on the specimens of the type collection) is "Berkeley Sound, Falkland Islands," where it grew "on rocks." Skottsberg (*loc. cit.*) collected it at the Falkland Islands, growing on *Mytilus* and in tide pools, at several localities, as well as in South Patagonia (on *Mytilus,* in Fitzroy Channel).

The distinguishing feature of *Iridophycus dichotomum* and of the section *Chondriridaea* is the branching, fimbriate apophysis (or stipe plus apophy-

sis?). The marginal emergences of the apophysis are elongated into long subulate processes or into leaflets, and are continued on the margins of the leaflets and blades as denticula or as broad dentations. The apophysis shows no tendency toward being canaliculate, even when dry, and no surface emergences have been seen on the apophysis, the leaflets, or the blades. In this, as well as in the greater freedom in branching, this section differs from the next.

The luxuriantly developed plants of *Iridophycus dichotomum* have been taken by Kuetzing for his *Iridaea dentata,* whereas the juvenile or dwarfed specimens have been indicated by him either as *I. dentata β minor* (Spec. Alg., 729, 1849) or later as *I. dichotoma* (Tab. Phyc., 17, pl. 13, figs. *c, d,* 1867). Hooker and Harvey included both under their *Iridaea dichotoma* of 1845. According to their description, the stipe is short, cartilaginous, soon cuneate furcate or several times dichotomous, gradually passing into an ample cuneate or obovate membranaceous frond, with segments either simple, entire or furcate or dichotomous, denticulate or coarsely dentate on the margin or lobed or emitting new fronds of a thin, shining, lubricous consistency, at length verrucose with the very numerous immersed fructifications.

Sections were made of a young cystocarpic blade of a specimen in Herb. N. Y. Bot. Garden, of the Berkeley Sound collection of J. D. Hooker. The sections swell up (seemingly normally) to 190–250μ in diameter, the medulla taking up about two-thirds of the thickness. The filaments of the medulla are 3–4μ in thickness and form a reticulum which is lax with elongated meshes. The cortices are made up of 7–8 cells in the series, the innermost somewhat larger and almost globular, the successive cells outward gradually decreasing in diameter, but still globular, whereas the outermost cells are 3–4 times as long as broad and bluntly conical. Young procarps are abundant and young cystocarps show a thick *pericarpium proprium* surrounding the still juvenile gonimoblastic mass.

Iridophycus dichotomum seems a perfectly distinct species, recalling *I. laminarioides,* but more definitely the *I. Boryanum* of our account. It seems more austral, ranging apparently from South Patagonia (Fitzroy Channel, Skottsberg) to the East Falkland Islands. It is more chondroid than any of the other species of *Iridophycus* with which we are acquainted, in its dichotomies and in having the lateral "proliferations" only marginal. This contrasts this section, *Chondriridea,* with the next section, where the lateral proliferations are both marginal and superficial as in typical *Gigartina* species.

Sectio IV. **Gigartiridaea** S. et G.

Setchell and Gardner, Proc. Nat. Acad., 22:471, 1936.

To the section *Gigartiridaea* are referred two species (or sets of species?) which, while varying much and seemingly individually, nevertheless seem properly separate from the other species of *Iridophycus,* in that, besides the expressed, suppressed, or all but suppressed dichotomy, which may be supposed to be the normal expression of complexity of the fronds, there are lateral emergences of the apophysis and blade which suggest somewhat similar ex-

pressions in the various groups of species of the genus *Gigartina* (see Setchell and Gardner, Univ. Calif. Publ. Bot., 17(10) :258–263, 1933). The species of *Gigartiridaea* and *Gigartina,* when viewed from the same viewpoint, show similar tendencies toward lateral branching. In *Euridaea* there is little of this, unless it may be the tendency, sporadic or uniform in some species, to form marginal callosities or teeth on the blade (but not on the apophysis). In *Porphyridaea* and *Chondriridaea,* lateral outgrowths are found on both apophysis and blade, in the former taking the form of leaflets, usually only from the margins but rarely also from the surfaces of the apophysis and blade, in the latter only from the margins. In *Gigartiridaea,* however, even though at times the tendency may be slightly or possibly in some individuals completely suppressed, the lateral emergences take place both from the margins and from the surfaces of the apophysis and the blades, particularly from the margins. This is probably a slight expression of the dynamic (or phyletic?) indication of a tetrastichous (or quadrifarious) structural organization, more feebly or more strongly expressed. Of itself, in *Iridophycus,* it might not seem of fundamental significance, but from comparison, particularly with the similar tendency in the related genera *Chondrus* and *Gigartina,* it obtains credulity.

While there are some difficulties in segregating the species properly belonging to *Gigartiridaea,* because of unequally developed, or even suppressed (?) lateral emergences in different plants of the same species, it is even a much more difficult matter to find proper lines of cleavage among the species and to adjust the application of the various binomials, such as *I. undulosa* Bory, *I. crispata* Bory, *I. micans* var. *ciliolata* H. f. et H., and *I. ciliata* Kuetz., as well as those which have been placed under that miscellaneous aggregate which has been referred to the *Iridaea radula* (Esp.) Bory (or *Gigartina radula* (Esp.) J. Ag.) Two difficulties are resident in any attempt to clarify the situation in *Iridophycus:* the first is to obtain a proper evaluation of the constancy or limits of constancy of the morphological characters as related to logical and comprehensible cleavage of specific groups; the second, to rescue from the welter of miscomprehension such entities and lines of cleavage on the one hand and the setting up of various binomials, their strict content, their extended content, and their relation to some finally revised and pertinent concepts with respect both to cleavage lines and to proper binomials, on the other. The situation among the alleged species of the section *Gigartiridaea* is the most obscure—and with the least fundamental data to work upon—within the entire range of *Iridophycus.* The following attempt cannot be regarded as other than most tentative, but the more general idea of unwieldy megaspecies, held by previous writers (including ourselves) has been abandoned in an attempt to apply (as previously in this account) a reasonable concept of more limited, possibly even microscopic, aggregations. Bory (*loc. cit.* var.) united plants of the Falkland Islands with those of Concepción, Chile, possibly correctly, but also possibly in less discriminating lumping, abandoning, however, earlier binomials as unsuitable and substituting new ones. This process extended from the list in the Flore des Malouines through the Dictionnaire

classique d'histoire naturelle, to the final pronouncement in the Botany of the Voyage Coquille. Whether his *Iridaea undulosa* (Falklands) is to be replaced by his *I. crispata* (Concepción, Chile) and finally by his *I. Augustinae* (Concepción, Chile) as he indicates, or whether each of these represents a distinct and autonomous species, cannot at present be followed with certainty, either through his various accounts or through the specimens retained by him in his herbarium, which latter, so far as careful search reveals, have only the "etiquette" of the Voyage Coquille. For reasons to be given later, these three binomials of Bory seem to us to have been given to at least two separate types of plants and will so be treated in the following account. Hooker and Harvey, in their three treatments, (1) London Jour. Bot., 4:262, 263, 1845, (2) Flora Antarctica *in* Bot. Antarct. Voy., I:188, 189, 1845, (3) *ibid.*, II:485, 486, 1847, vary from including all their plants under *Iridaea radula* (Esp.) Bory to segregating them under this species and under *I. cordata* (Turn.) Bory, but they have distinguished a *ciliolata* form, which is helpful, although puzzling. In contrast with the very inclusively broad idea of Hooker and Harvey, Kuetzing (Spec. Alg., 724–729, 1849, and Tab. Phyc., 17, pls. 3–20, 1867) has taken the extreme opposite view of narrowly delimited species and has drawn attention to *I. ciliata*. Of the *Gigartiridaea* section there are to be considered, then, the following:

I. undulosa Bory (type, Falkland Is.)
I. crispata Bory (type, Concepción, Chile)
I. Augustinae Bory (type, Concepción, Chile)
I. micans var. *ciliolata* H. f. et H. (type, St. Martin's Cove, Fuegia)
I. ciliata Kuetz. (type, "Valparaiso, Chile")

In the following paragraphs it has seemed best to discuss each one of these binomials as a possibly separate entity, bringing to bear such material or suggestion as may seem pertinent to each.

A. Base of blade cuneate to reniform, but not pronouncedly cordate
B. Emergences simple

9. **Iridophycus undulosum** (Bory) S. et G.

Plates 25 and 26

Setchell and Gardner, Proc. Nat. Acad., 22:471, 1936; *Iridaea undulosa* Bory, *in* D'Urville, Flore des Malouines, 594, 1826; *Iridaea Augustinae* Bory, Bot. Voy. Coq., 109, pl. 12, fig. *E*, 1827 (only with respect to younger plants); *Iridaea micans ciliolata* Hooker fil. et Harvey, London Jour. Bot., 4:263, 1845; *I. cordata* var. *β ciliolata* Hooker fil. et Harvey, *in* Hooker, Flora Antarctica, 2:485, 1847.

In the Flore des Malouines, Bory (*loc. cit.*) gave only the briefest of diagnoses to this species, nor did he add anything to this in his only other reference (see Voy. Coq., *loc. cit.*) when he repeated the same diagnosis of *I. undulosa*, placed as a synonym under his *I. Augustinae*. Unfortunately, also, search has not revealed any specimen in Herb. Bory inscribed with this name. It is extremely doubtful, therefore, whether the *I. undulosa* Bory is only a state of

what he later called *I. Augustinae* or whether it may be a distinct species. In the Flore des Malouines, Bory proposes 3 names in *Iridaea:* 1, *I. micans;* 2, *I. undulosa;* and 3 *β I. papillosa;* 1 and 2 with diagnoses, 3, merely mentioned by name. No. 1 is probably the same as that of later works; no. 3 is (*fide* specn. in Herb. Bory) a *Gigartina,* but no. 2 is our immediate problem. Several courses are open, each subject to uncertainties: to accept Bory's identification of his *I. undulosa* with his later *I. crispata* and his even later *I. Augustinae;* (2) to consider it as identical with *I. Augustinae* only; or, (3) to consider it as an autonomous species.

Bory (Flore des Malouines, 594) says that *Iridaea undulosa* is smooth, with ovate-conic frond, with base obconic, and a rather thick, undulate crisped blade. The "smooth" character is probably to distinguish it from "*β I. papillosa,*" not described except for its designation (as papillose). *Iridaea papillosa,* however, *is* described in the Dictionnaire classique (p:16, 1826) as dissected and laden with papillae. In 1827 (Bot. Voy. Coq., p. 107), Bory places it under his *Iridaea radula* and his herbarium specimen shows it to be a *Gigartina.* As to *I. Augustinae,* Bory says (Bot. Voy. Coq., p. 109) that his first specific "phrase" was given to certain little-developed specimens of a form attenuated into a wedge at the base. In maturing, he says, the plant, contrariwise, takes on a heart-shaped form and develops into a rounded, semidiaphanous blade, undulate and crisped on its periphery in a singularly graceful fashion. One cannot be withheld from associating the plant represented in figure *E* of plate 12 (Bot. Voy. Coq.) with what Bory says about his *Iridaea undulosa* and from suspecting that it represents a different species from the ample, heart-shaped plants, figured *A, B, C,* and *D* on the same plate, which may properly be referred to *I. Augustinae* Bory which came from Concepción. No definitely authenticated specimen of *I. undulosa* (as restricted) was seen in Herb. Bory unless it was a small plant on the same sheet with what was certainly intended to be the type of *I. Augustinae,* but it, itself, was not labeled either with respect to either its identity or its locality.

Assuming, as it seems with some reasonable degree of probability, that *Iridaea undulosa* Bory is represented by figure *E* of plate 12 of the Atlas of the Botany of Voyage Coquille, and is described on p. 109 (bottom of page) under the designation "échantillons peu developpés, que nous avions, dans notre premier phrase specifique," and so forth, it is a plant narrowed into cuneate shape at the base, with at least a few long fibrillae from the basal margins of the apophysis, gradually or somewhat more abruptly broadening above into an ovate or obovate blade, undulate, entire or deeply laciniate, more brownish, or brownish purple, with cystocarps thickly scattered and present even in a plant no longer than 8 or 10 cm.

Iridophycus undulosum (Bory) S. et G. is to be sought for among collections from the Falkland Islands referred particularly to *Iridaea Augustinae,* but some are under *I. cordata* or *I. micans.* Unfortunately, at present few of these are accessible. They are to be looked for among the extensive collections of 1901–1903 and those of the Swedish Expedition to Patagonia and Fuegia of 1907–1909, made by Skottsberg (mostly preserved in alcohol). The dried

specimens of these collections, preserved in Herb. Mus. Bot. Stockholm, Herb. Mus. Upsaliense, Herb. N. Y. Bot. Garden, and Herb. Univ. Calif., have been made accessible, but they represent only a few of the specimens quoted. One sheet of specimens of the South Polar Expedition, collected at Ushuaia, Fuegia, labeled *"Iridaea Augustinae"* by Skottsberg (see plate 25), but reported (Kylin and Skottsberg, Wiss. Ergebn. schwed. Südpol. Exp., 1901–1903, 4, 15 :7, 1919) under *I. laminarioides,* definitely ciliated on the basis (apophysis) seems referable here. The several fronds in the group are brownish red, the apophyses are narrower to broader wedge-shaped, the marginal ciliation is pronounced, becoming serrulate on the margins of the blade. The blade is more lanceolate or more ovate as it develops out from the apophysis, but is not pronouncedly cordate even when mature, whereas true *I. Augustinae* (*fide* Bory, *loc. cit.*, pl. 12, figs. *A–D*) have truly cordate bases from a very early stage. The specimens of Skottsberg (Herb. Univ. Calif., no. 205718), from Ushuaia, Staten Island (sta. 10*a*), which we assign tentatively to the *I. undulosa* Bory, form a clump from the same (confluent?) attachment (three larger and about six smaller fronds). They are up to 12 cm. long and 5 cm. in extreme width, are brown, with narrow cuneate apophysis, about 2 cm. high, expanding somewhat abruptly into an ovate or lanceo-ovate frond, narrowing gradually above the base. The margins of the apophysis are bristly with short fimbriae or even leaflets, whereas the margins of the blade are serrulate. The surfaces of the apophysis and lowest part of the blade are rough with microscopic sharp projections. The blades show rather young cystocarps.

A transverse section of the Ushuaia plant is about 250μ in diameter, with the medulla 185–190μ across, containing a lax reticulum of delicate fibers (1.5–2μ thick). The cortices are made up of about 7–8 series of cells, the outer somewhat larger and laxly placed, nearly globular, but gradually diminishing in size to the outermost cells of the closely packed anticlinal rows, to the superficial layer of only very slightly elongated oblong, obtuse cells. The young cystocarps are situated to one side or the other of the medulla and have a dense concentrically filamentous *pericarpium proprium.*

There are in Herb. William Randolph Taylor several specimens of *Iridophycus undulosum,* in the foregoing sense, as follows: East Falkland Islands; Stanley Harbor, leg. Waldo L. Schmitt, no. 123; Strait of Magellan; Laredo Bay, January 22, 1888, Albatross Expedition, no. 51; Magdalene Islands, Hassler Expedition, nos. 2063, 2064, 2065, and 2082; Bahia Tandy, Smith Channel, Hassler Expedition, nos. 2046 and 2048.

Iridophycus undulosum, as interpreted by us, seems a smaller, brownish to brownish purple species, with a rather broad cuneate apophysis and a more or less rounded base to the blade, less abruptly dilated than in true *I. Augustinae* and probably never strongly cordate. The type evidently was collected in the Falkland Islands by Lesson and the species may extend southward to at least Ushuaia in Fuegia. Nothing like it has been noted among such collections from the Chilean coasts as have been accessible.

The var. *ciliolata* Hooker fil. et Harvey, referred to *Iridaea micans* and

later to *I. cordata*, through the kindness of the authorities at Kew, has been studied in the type specimens from St. Martin's Cove, Fuegia (see plate 26), and is clearly *Iridophycus undulosum* as understood above.

BB. Emergences compound

10. **Iridophycus ciliatum** (Kuetz.) S. et G.

Setchell and Gardner, Proc. Nat. Acad., 22:471, 1936; *Iridaea ciliata* Kuetzing, Spec. Alg., 726, 1849, Tab. Phyc., 17:4, pl. 10, 1867; *Iridaea micans* J. G. Agardh, Spec. Alg., 3, 1:181, 1876 (with respect to synonym of Kuetzing only).

Kuetzing founded his *Iridaea ciliata* on specimens from the Island of Chiloé, Chile (*fide* type specimens in Herb. Kuetzing!), but both in the Species Algarum (1849, p. 726) and in the Tabulae Phycologicae (17:4, 1867) he has credited the species to Valparaiso. Kuetzing states that the blade is large, very broad, corriaceous (perforated), obovate, or suborbicular, with the margins adorned with minute *branched* cilia, bearing retuse cystocarps in the blade, and having a lax perenchymatous (dictyenchymatous) structure. Kuetzing suspects that it may be the same as the *Iridaea cordata β ciliolata* H. f. et H. (of the Cape Horn region), but that variety is clearly to be referred under *I. undulosum.* The species of Kuetzing has long been placed either under the general *I. cordata* Auctt. or under the somewhat more particular *I. micans* Auctt., whereas its true relation, seemingly seldom suspected, must, because of the "cilia" on the apophysis and blade, be rather with the *I. crispata* Bory (type from Concepción) and with *I. Augustinae* Bory (true type from Concepción).

In Herb. Kuetzing are three sheets of specimens, all from San Carlos, Chile. On one sheet are two specimens, one of which is the original of plate 10 of volume 17 of the Tabulae Phycologicae. The bases of all are incomplete, but the elliptical blade is supported on a fragment of the flat, broadly cuneate apophysis (see Kuetzing's figure *a*), which is not only "ciliate" on the margins but on the surface as well. The greater part of the blade, all above the very base, seems smooth, even to the touch. On a second sheet are two cystocarpic specimens with the label of Hohenacker's Meeresalgen, no. 445, each of which lacks the very base, with rough margins and rough to the touch at the bases of blades. On the third sheet are three specimens, all the no. 445 Hohenacker, two cystocarpic and one tetrasporic. In one, the basal part (apophysis) is flat, 2–3 cm. long, strongly ciliated on the margins, and with surface rough, in one specimen even well up on the blade. The spinules are nearly all, although short and even microscopic, more or less branched as described by Kuetzing, and seemingly regarded by him as distinctive of the species. Undoubtedly the species tends toward being cordate, although possibly only slightly reniform, with emergences tending to be branched, and varying much with respect to roughness of the surface of the blade.

Transverse sections of the blade of specimens in Herb. Kuetzing answer to Kuetzing's statement: "Structura laxissime perenchymatica," and fairly well to his figure *b* on plate 10, if allowance be made to the diagrammatic represen-

tation of the structure of his Iridaeas, Gigartinas, and so forth, particularly of that of the cortex. It is very thin when dry, but swells up (normally?) to about 375μ, and of this the medulla occupies about 280–315μ, with a lax reticulum of delicate filaments (1.5–3μ diam.) loosely filling it. The cortices are 30–40μ thick, of about 4–5 series of cells, the inner 3 or 4 globular and segregated, only slightly larger than the outer ones, the outer 2 forming dense anticlinal rows, the inner cell globular to appressed-globular, the outer one oblong, usually slightly longer than broad, and obtuse truncate on the outer end.

The cystocarps are nearly globular, especially when young, about 600μ in diameter, with a thick *pericarpium proprium,* situated in locally swollen parts of the frond, about equidistant from each surface. The sori, formed just below one or the other surface, with accessory tetrasporangia, seem small (about 375–520μ in horizontal diameter and 100–120μ in vertical diameter).

The only collections of *Iridophycus ciliatum,* other than the type collections, thus far available to us, are in Herb. N. Y. Bot. Garden. They are both from Valparaiso, Chile, and were communicated from the Herb. Paris by R. E. Bustos. No. 28 is an elongated blade about 34 cm. long and up to 14 cm. wide, very widely cuneate at the base, with only a short part of the broadly cuneate apophysis remaining. This has emergences on the margins, is barely rough on its surface, whereas the blade shows distant microscopic but branched callosities on its margins. It resembles closely the type plants of Kuetzing. No. 26, however, is a short plant, slightly more than 9 cm. in each diameter, with a short fragment of the flat apophysis below the rounded, slightly reniform base of the blade. Both margins and surfaces of both apophysis and blade show minute but stout branched papillae. With these emergences it is rough enough to be superficially associated with the heterogeneous assemblage formerly grouped under *Iridaea* (now *Gigartina*) *radula.* No. 28, although showing neither cystocarps nor sori, seems to be only an extreme manifestation of *Iridophycus ciliatum.*

AA. Base of blade truly cordate; emergences simple

11. **Iridophycus crispatum** (Bory) S. et G.

Setchell and Gardner, Proc. Nat. Acad., 22:471, 1936; *Iridaea crispata* Bory, Dict. class. d'hist. nat., 9:16, 1826; *Iridaea Augustinae* Bory, Bot. Voy. Coq., 108, pl. 12, 1827; Kuetzing, Spec. Alg., 726, 1849; J. G. Agardh, Spec. Alg., 3, 1:181, 1876 (excl. syn.); De Toni, Syll. Alg., 4, 1:188, 1897 (excl. syn. *I. dentata*).

The question of reviving the *Iridaea crispata* Bory, instead of the earlier *I. undulosa* Bory, to designate the species to which Bory, in such parental ecstasy, finally gave the name *Iridaea Augustinae,* has been partly explained under *Iridophycus undulosum.* The discrepancies between the plants of the Falkland Islands, described under *"undulosa,"* both morphological and geographical, and those of the Chilean coast to which Bory first gave the name *"crispata"* and later that of *"Augustinae,"* seem sufficient. There comes, however, still another query, and that is whether both those which Bory received from Lesson and to which he gave the name *"crispata"* and those which he

received from D'Urville and to which he gave the name *"Augustinae"* belong to the same species. Both sets of specimens came from Concepción ! The question arises and must probably remain unanswered, with respect to whether *I. crispata* Bory really was founded on what Bory later called *I. Augustinae* or whether it may have been based on the plant which Kuetzing later described as *I. ciliata*. If Bory had a specimen of *I. ciliata* Kuetz., as distinguished from his *I. Augustinae,* it did not appear in a careful search of what remains of his collections of Iridaeas in Herb. Mus. Paris (!) made with this object in view. We feel fairly well justified, therefore, in assuming that the *I. crispata* of Bory is only the earlier name applied by Bory to the *I. Augustinae* from Concepción.

As depicted by Bory on plate 12 of the Atlas of the Bot. Voy. Coq. and in figures *A–D* (excluding fig. *E*), *Iridophycus crispatum* assumes its cordate base early in its development (see fig. *A*). The stipe and apophysis are comparatively slender, the latter very narrowly cuneate and inrolled (at least after drying). The emergences on the margins of the apophyses are mostly blunt and wartlike; those on the margins as well as on the surfaces of the blade seem confined to the basal regions and are unbranched and spinose. Of the four fronds of the plate, only one (that of fig. *D*) is preserved on the sheet of *"Iridaea Augustinae* Pag. 108, pl. 12, figure *D,* côtes du Chili, à la Concepción. D'Urville 1825." There is, however, on this sheet but not on the original paper, a much smaller frond, probably of juvenile stage, which has only a broadly rounded base to the blade, but with characteristic elongated stipe and apophysis with only a few minute emergences present on the margins of the basal parts of the blade and uppermost parts of the apophysis. This specimen may be a young plant of *I. undulosum.*

No collections of *Iridophycus crispatum* are known other than that of D'Urville from Concepción, Chile, to which Bory gave the name *Iridaea Augustinae,* since the plants from the same locality which were collected by Lesson, and to which Bory originally gave the name *Iridaea crispata,* cannot, at present at least, be located. The habit is well represented in Bory's plate 12*A–D*. The stipe and apophysis are elongated and slender, canaliculate above, and with simple emergences on both margins and base of the blade. The fairly ample blade, in plant "D" is thin (185–250μ), with medulla occupying about half the thickness and the cortices each a little less than a quarter. The cells of the cortices are in series of 8–9 cells in each vertical row, the inner globular and larger, suddenly diminishing to the closely packed anticlinal rows of elongated cells, the outermost elongated rod-shaped. The plant seems antheridial and this, possibly, accounts for the elongation of the cells in the anticlinal rows. The section seems different, in general view, from that of *Iridophycus ciliatum.*

The survey of South Amercian species of *Iridophycus* recognizes 11 which seem distinct. In distribution they seem definitely, so far as present evidence is concerned, to be segregated into two groups; those of the southeast coasts and those of the southwest coasts. *Iridophycus micans, I. dichotomum,* and

I. undulosum are of the Falkland Islands, the last-named extending also well south to Fuegia, joining *I. obovatum* and *I. caespitipes.* On the Chilean coasts are found *I. Boryanum, I. laminarioides, I, micrococcum, I. membranaceum, I. ciliatum,* and *I. crispatum.* All the species seem to be endemic to the South American coasts.

The 11 species discussed, so far as the limited material and information allow, in the foregoing paragraphs, include all members of the genus *Iridophycus* known to us from South America. In the course of the investigation a few other South American or austral plants originally (or still) referred to *Iridaea* have necessarily been considered and it seems best to present some notes concerning them. Two boreal "Iridaeas," which have been investigated with the austral, are also appended.

Gigartina papillosa (Bory) S. et G.

Plate 27

Setchell and Gardner, Proc. Nat. Acad., 22:472, 1936; *Iridaea papillosa* Bory, *in* Dict. class. d'hist. nat., 9:6, 1826; *Iridaea undulosa β I. papillosa* Bory, *in* Dumont D'Urville, Flore des Malouines, 594, 1826; *Iridaea radula* Bory, Bot. Voy. Coq., 107, 1827 (p.p.). *Gigartina radula Auctt. Aliorum* (with regard to the plant from the Falkland Islands) (non *Fucus radula* Esper!).

The type specimen, collected by Lesson, in the Falkland Islands, is preserved in the herbarium at Paris (see pl. 27). It is most clearly a *Gigartina,* not only having stout papillae from the surfaces of the frond, but also having the cystocarps borne in these papillae. The binomial *Iridaea papillosa,* however, does not occur on the herbarium sheet. It presumably belongs to the subgenus *Chondrodictyon* (see Setchell and Gardner, Univ. Calif. Publ. Bot., 17(10) :278, 295, 296, 1938), since another plant (Roy Cove, West Falkland Islands, leg. Mrs. Elinor Vallentin, August, 1900, Herb. Kew!) with the same habit and general structure, thickly provided with papillae and with lacunae, shows the tetrasporangial sori, embedded in the tissue of the blade itself (not in the papillae) and accessory in origin. It seems necessary to transfer Bory's plant to the genus *Gigartina* and to propose the new combination *Gigartina papillosa* (Bory) S. et G., as given above. The plants arise from a small disk, with distinct, very soon compressed, thick stipe up to 1 cm. (or more) high, beset with outgrowths of several degrees of development from short curved spines to elongated, narrower to broader leaflets, the latter laminate, pinnatifid, with smaller leaflets on the margins and branched papillae on the surfaces, interspersed with rounded perforations of varying sizes; cystocarps swollen in the continuity of stout, moderately acute, slightly ramose papillae; tetrasporangial sori embedded in the blade, accessory in origin. Plant up to 18 cm. high or more, with divisions spreading out at oblique angles to produce a fan-shaped frond, with a horizontal spread equaling or nearly equaling the vertical. The color varies from clear rose purple to purplish brown, according to age, exposure, and so forth, and the texture is moderately thick and cartilaginous when dry.

The type specimen, in Herb. Bory, is labeled "*Iridaea radula* N. Coq. p. 107, des Iles Malouines, par Lesson, 1825" (see pl. 27). Three specimens collected by Mrs. Elinor Vallentin, in Herb. Kew, are respectively from Roy Cove, West Falklands, August 1900 (tetrasporic!), West Point Island, West Falklands, May 1910 (cystocarpic!), and Rapid Point, Port Egmont, West Falklands, March 1911 (cystocarpic!). Also in Herb. Kew (!) is a rather smooth but cribrose, tetrasporic specimen from Tristan d'Acunha, which seems to belong here, and two specimens from Kerguelen Island, one collected by the Reverend A. E. Eaton on the Transit of Venus Expedition, 1874–1875, the other collected by the Antarctic voyage of 1840. Probably the *Gigartina* (*spinosa* var.?) *runcinata* Grunow (Algae Novara Exp., 71, 1868) from the Island of St. Paul, is to be placed under the *Gigartina papillosa* (Bory) S. et G. The varietal (or specific?) name of Grunow is most appropriate for this species, which seems to extend from the Falkland Islands through Tristan d'Acunha, Inaccessible, and St. Paul Islands to Kerguelen Island.

Gigartina Skottsbergii S. et G.

Plates 28 and 29

Setchell and Gardner, Proc. Nat. Acad., 22:472, 1936; *Iridaea radula* Hooker fil. et Harvey, Flora Antarct., II:485, 1847 (p.p.); *Gigartina radula* Cotton, Jour. Linn. Soc., 43:177, 1915 (p.p.); Kylin and Skottsberg, Wiss. Ergeb. schwed. Südpol. Exp., 1901–1903, 4, 15:8, 1919 (p.p.); Skottsberg, K. Sv. Vet.-Akad., Handl. 63, 8:9, 1921 (p.p.) (non *Fucus radula* Esp.!).

The plants which may be placed with confidence under this species show a very wide range, all the way from the Falkland Islands, through Fuegia, and, possibly, up along the coast of Chile, to as far north as Valparaiso, Chile. The following localities may be noted: *Falkland Islands:* The Antarctic Voyage (Erebus and Terror), January, 1843, (3 sheets, cystocarpic! and antheridial (?), Herb. Kew!); British Antarctic Expedition (Discovery) 1901–1904 (Herb. Kew!), Stanley Harbor, East Falkland Islands, leg. Waldo L. Schmitt, no. 113, (tetrasporic type!), "Falkland Islands," leg. A. E. Douglas, 1893 (cystocarpic!, Herb. Farlow!); *Fuegia:* St. Martin's Cove, Cape Horn, The Antarctic Voyage, Erebus and Terror (Herb. Kew!), tide pools, Slogget Bay, March 16, 1909, Skottsberg (cystocarpic! and antheridial!, Herb. Univ. Calif. no. 205704, type!), Puerto Bueno, Hassler Expedition, no. 102 (cystocarpic!, in Herb. William Randolph Taylor); *Patagonia:* Orange Harbor, U. S. Exploring Expedition, Wilkes (U. S. Nat. Herb.! et Herb. N. Y. Bot. Garden!), same locality, collector?, (Herb. Kew!); *Chile:* Valparaiso, Bustos, no. 30 (antheridial?, Herb. N. Y. Bot. Garden!).

The "*Iridaea radula*" of Hooker and Harvey (*loc. cit.*) was not only *not* the *Fucus radula* Esper, but was a most general specific conception, including almost all broad-bladed plants, either of *Gigartina* or even of *Iridaea,* which show papillae on the surface of the blade. Under their *I. radula,* they included at least *Iridophycus undulosum, Gigartina papillosa,* and *G. Skottsbergii,* as a study of their specimens demonstrates. *G. Skottsbergii* is one of the largest and thickest of the *Chondrodictyon* subgenus and is easily recog-

nized by one or more of its several peculiarities. Attention is attracted to the statement of Hooker (Fl. Antarctica, II:486, 1847) where he speaks of "the heavy waves washing almost uninjured fronds of the *I. radula* ashore in broad sheets as large and as red as an ordinary pocket handkerchief." Just how large and how red this may be is difficult to determine after the passing of nearly a century of time, but the expression of size and color is still vivid and provocative to the imagination.

Gigartina Skottsbergii seems certainly to be limited to the South American coasts and differs from all other Gigartinas as yet described, in having an umbilicate attachment. When very young it seems to have the very short stipe attached somewhat near to the central point of the lower surface of the umbilicate frond, but still eccentric. No such simple early state has been observed, but one frond (Valparaiso, Bustos no. 30, Herb. N. Y. Bot. Garden) shows it still existing but surrounded by several irregular circles of very similar short, stout hapteres (see pl. 28). The fronds attain to a considerable size (even up to 4 or 5 decimeters in diameter), become elongated, undulate, lobed, repand, and lacerate, assuming many shapes. The upper surface bears papillae, few or none in antheridial plants, sparse in tetrasporic plants, but thickly placed in cystocarpic plants (see pl. 29). Papillae may also occur sparsely or irregularly on the lower (i.e., attached) surface but are sparse and of irregular placing. Within the margins of the papilliferous plants there is usually a narrow naked zone, but in older cystocarpic plants this may be obscured and fructiferous papillae may spring from the blunt, seemingly slightly thickened margins themselves. The nearest relative is *G. apoda* J. Ag. of New Zealand, but that, although usually and decidedly dorsiventral, is never umbilicate, nor strictly orbicular, even when young. The species is most noteworthy, is apparently abundant, at least from the Falklands to Fuegia and southern Patagonia. The Valparaiso specimen seems "out of range." It is a pleasure to dedicate this species to Professor Dr. Carl Skottsberg of Göteborg Sweden, who vies with D'Urville and J. D. Hooker in the extent and value of his collections of austral American *Gigartinaceae*.

Rhodoglossum macrodontum (Skottsberg) S. et G.

Setchell and Gardner, Proc. Nat. Acad., 22:472, 1936; *Iridaea macrodonta* Skottsberg, K. Sv. Vet. Akad., Handl., 63, 8:8, 9, fig. 1*b*, 1923; *Iridaea cordata* Cotton, Jour. Linn. Soc., 43:177, 1915 (p.p.).

This species, until the present known only from South Georgia, was recognized by Skottsberg as belonging to the *Rhodoglossum* series of *Iridaea,* because of the intercalary development of the tetrasporangia in its sori. It seems to be a very distinct species, and a plant answering in all essential details to the description has long been preserved in the Herbarium of the University of California (no. 207096). This specimen is one of those collected in the Falkland Islands by Mrs. Elinor Vallentin. Its habit resembles very closely that of *Iridaea micans* Bory (see Atlas, Bot. Voy. Coq., pl. 13), having the elongated, narrow (up to 2.5 cm. long and 3–4 mm. broad at top) canaliculate, apophysis-stipe, enlarging suddenly into the deeply cordate base of

the cordate-reniform blade, whose margins are very coarsely dentate and cuneate lobed. The specimen is deep wine red, firmly cartilaginous, with young sori, closely placed, and with intercalary tetrasporangia as described by Skottsberg. Because of its habit, it was first associated with *I. micans* Bory and was one of the "two extreme forms" mentioned by A. D. Cotton (Jour. Linn. Soc., 43:177, 1915) as having been sent to one of us (W.A.S.); at a time when ideas of polymorphism in the genus *Iridaea* were far more tolerant and vague than intervening experience, such as is partly expressed in the foregoing paragraphs, has sustained. This species is, thus far, the only South American *Rhodoglossum* known. The species of the genus are more numerous, although specimens are by no means common, on the coasts of New Zealand and of extratropical Australia. Rhodoglossums are also known associated with Iridaeas, on the temperate parts of the west coast of North America, and even into northwestern Asia (*Rhodoglossum pulchrum* S. et G., Proc. Nat. Acad., 22:472, 1936; *Iridaea pulchra* Kuetz., Spec. Alg., 725, 1849, Tab. Phyc., 17:2, pl. 5, figs. *c, d,* 1867; Yendo, Bot. Mag. Tokyo, 31, 363: 81, 82, 1917). The only coasts possessing *Iridaea* without accompanying *Rhodoglossum* seem to be those of the Cape region in South Africa.

Phyllymenia Belangerii (Bory) S. et G.

Setchell and Gardner, Proc. Nat. Acad., 22:473, 1936; *Iridaea Belangerii* Bory *in* Belanger, Voy. aux Ind. orient., etc., Bot., pt. 2, 160, pl. 15, fig. 1, 1846; *Iridaea capensis* var. β J. G. Agardh, K. Sv. Vet.-Akad. Handl., 85, 1847 (p.p. ut. pl. Boryanam); *Phyllymenia hieroglyphica* J. G. Agardh, K. Vet.-Akad. Handl., 86, pl. 2, 1847.

In 1847, J. G. Agardh (*loc. cit.*, p. 85) placed (with a query) the *Iridaea Belangerii* Bory as a synonym under var. β of his *Iridaea capensis* and Bory's species has remained in this equivocal position ever since that time. The Iridaeas of Herb. Bory having been subject to scrutiny in the studies leading up to the present writing, it was surprising to us to find that the Boryan specimens of *I. Belangerii* were in no wise related to *I. capensis,* but that the three specimens represented both the tetrasporic and the cystocarpic states of *Phyllymenia hieroglyphica* J. Ag. (*loc. cit.*). Apparently, the specific name *Belangerii* of Bory antedates the *hieroglyphica* of J. G. Agardh, and likewise the generic name *Phyllymenia* J. Ag. as determined by its type *Ph. hieroglyphica* J. Ag. antedates *Cyrtymenia* of Schmitz (La Nuova Notarisia, 7:16, 1896, etc.). It seems plausible that Schmitz overlooked the fact that J. G. Agardh had erected a special genus, *Phyllymenia,* for his *Ph. hieroglyphica,* since J. G. Agardh himself had later immersed it, species and all, in *Grateloupia* (J. G. Agardh, Spec. Alg., 2, 1:182–184, 1851, and *loc. cit.*, 3, 1:154, 155, 1876). At any rate *Phyllymenia* J. Ag., 1847, as set forth in *Ph. hieroglyphica* J. Ag., seems to be the proper name for the Grateloupioids with the tetrasporangia in sori, and the sori forming elongated nemathecioid swellings. The following changes in nomenclature, therefore, seem demanded.

1. *Phyllymenia Belangerii* (Bory) S. et G.

Setchell and Gardner, Proc. Nat. Acad., 22:473, 1936; *Ph. hieroglyphica* J. Ag. (*loc. cit.*), *Cyrtymenia hieroglyphica* Schmitz (*loc. cit.*), *Grateloupia hieroglyphica* J. Ag. (*loc. cit.*), *Iridaea labyrinthifolia* Kuetz. (Spec. Alg., 729, 1849, Tab. Phyc., 17, pl. 18, 1867), etc.

2. *Phyllymenia cornea* (Kuetz.) S. et G.

Setchell and Gardner, Proc. Nat. Acad., 22:473, 1936; *Iridaea cornea* Kuetzing, Tab. Phyc., 17:6, pl. 20, 1867; *Pachymenia rugosa* Holmes, Ann. Bot., 8:340, 1884; *Cyrtymenia cornea* Schmitz, Nuov. Notarisia, 7:16, 1896, *in* Engler u. Prantl. Naturl. Pfl.-fam., 1 Th., 2 Abtl. (Lief. 166, 167): 511, 1897, etc.

Iridaea fissa Suhr (Flora, 19, 1:340, Pl. III, figs. 26 and L, 1836; *Gigartina fissa* J. G. Agardh, Spec. Alg., 3, 1:201, 1876 (p.p.), etc.) still remains a puzzle. J. G. Agardh not only associated it with *Iridaea lanceolata* Harv. (in J. D. Hooker, Bot. Antarct. II, Voy. Fl. Nova-Zel., II:252, 1855), a pinnated species, but he associated the Suhr plant, of which he apparently had a poor specimen, also with *Sphaerococcus Burmannii* C. Ag. (Spec. Alg., 1:272, 1820), later referred to *Gigartina* and finally regarded as the tetrasporic plant of *G. stiriata* (Turn.) J. Ag.). The plant of Suhr seems, from description and figure, to be tetrasporic. There seems little to connect it with the New Zealand *I. lanceolata* Harv., which is, itself, little known. There is one suspicious circumstance, which of itself is not necessarily convincing, but which when taken with the general resemblance to *G. Burmannii* of the Cape region and, likewise, with the fact that nothing like the *Iridaea fissa* has been collected in South America since that time, and that is the fact that the specimen (or specimens?) of *I. fissa* Suhr are said to have been found among the hapteres of *L(aminaria) buccinalis,* a characteristic species (if determined correctly) of the South African Cape region, and although formerly credited to the Cape Horn region, is not usually now considered as a possible inhabitant of these coasts. Suhr (*loc. cit.*), also, describes an *Iridaea clavellosa,* from Cape Horn, which clearly resembles his *I. fissa,* but later writers have usually associated it with the tetrasporic *Gigartina Burmannii* (Ag.) J. Ag. (the *Scyothalia Burmannii* Kuetz., Spec. Alg., 739, 1849, Tab. Phyc., 17:19, pl. 64, 1867), with which the type specimen (!) seems clearly in agreement. Grunow (Algae Novara Exp., 77, 1867), also, refers the *Iridaca fissa* Suhr to *Gigartina Burmannii* (Ag.) J. Ag., and alludes to the possibility of the Agardhian idea that it may be the tetrasporic state of *G. stiriata* (Turn.) J. Ag. Whatever it may be, the general situation points here to a possible confusion of type localities for both *Iridaca fissa* Suhr and *I. clavellosa* Suhr, since plants closely resembling the figures of both of Suhr's species are found commonly among the Cape of Good Hope plants of the *G. stiriata-Burmannii* complex and are not known, other than by Suhr's reference, in the South American region. (See also Setchell and Gardner, Proc. Nat. Acad., 22:473, 1936.)

Callymenia pustulosa (P. et R.) S. et G.

Setchell and Gardner, Proc. Nat. Acad., 22:473, 1936; *Iridaea pustulosa* Postels et Ruprecht, Ill. Alg., 18, pls. 32, 40, figs. 94, 95, 1840.

The plates and figures of Postels and Ruprecht indicate a plant departing from *Iridophycus* in both habit and structure. The specimen retained in "Herb. Acad. Petrop.," examined in 1903, was both mislabeled and disorganized. In Herb. Farlow, a specimen from the original collection is scanty and

not characteristic for habit. The best specimen seen is preserved in Herb. Mus. Bot. Stockholm, giving something of habit and being excellent for structure. Early stages of procarps, together with structure, clearly indicate *Callymenia*. The specimen is labeled: "Herb. Acad. Petrop."—"*Iridaea* (*Gongylonema*) *pustulosa* P R."—"Ad portum St. Petri et Pauli."—"Camtschatkae"—"Exped. Lütk."

EXPLANATION OF PLATES

PLATE 23

Iridophycus obovatum (Kuetz.) S. et G.

Young specimen from Cape Roquemaurel, Grahams Land, by Carl Skottsberg on the Swedish South Polar Expedition of 1901–1903. (In Herb. Mus. Bot. Upsaliense.)

Photo, W. C. Matthews.

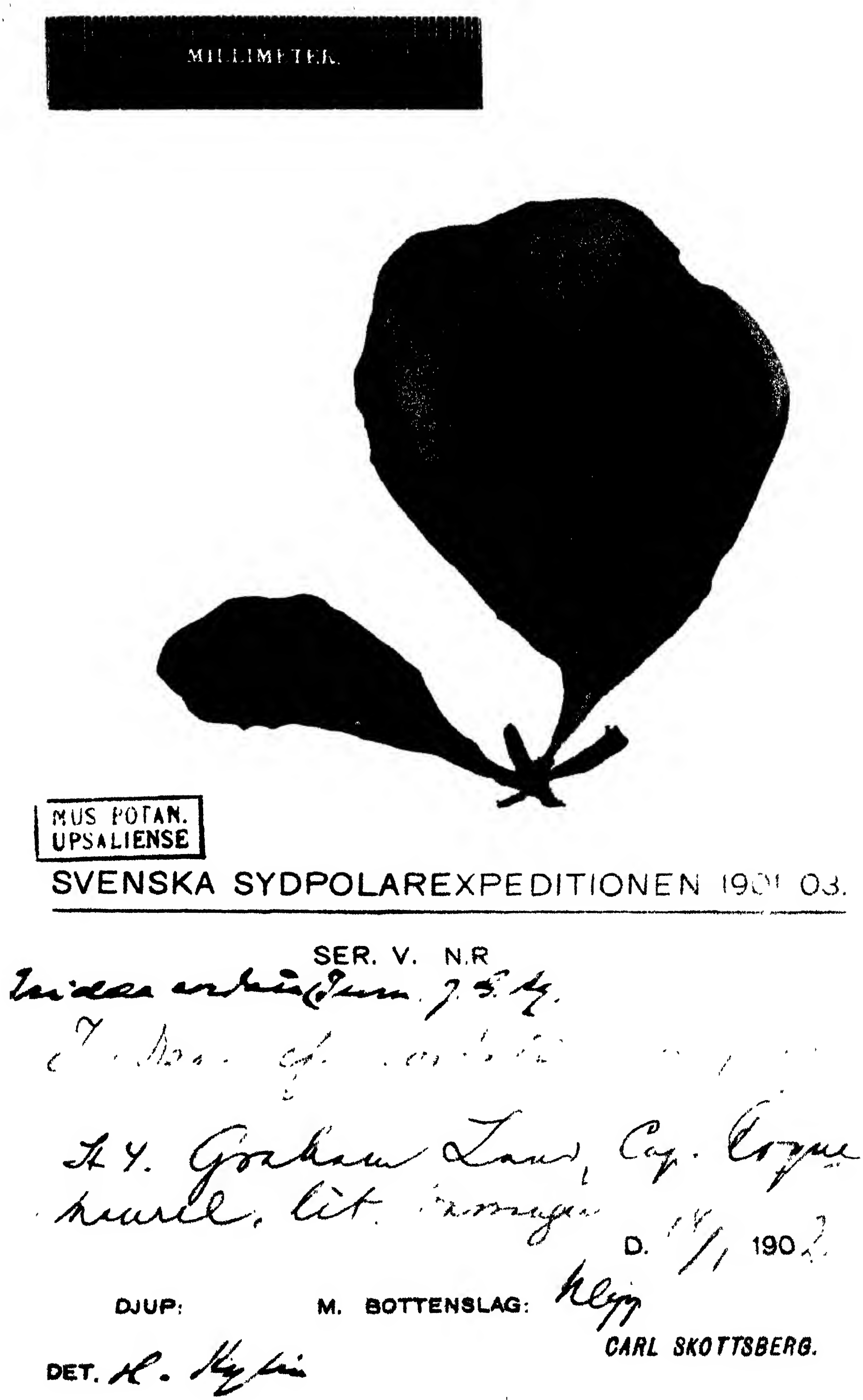

MILLIMETER.
MUS. BOTAN. UPSALIENSE
SVENSKA SYDPOLAREXPEDITIONEN 1901–03.
SER. V. N.R
D. 190
DJUP:
M. BOTTENSLAG:
CARL SKOTTSBERG.
DET.

PLATE 24

Iridophycus caespitipes S. et G.

Type sheet from Magdalene Islands, Strait of Magellan, by Hassler Expedition (no. 2066). (In Herb. William Randolph Taylor.)

Photo, W. C. Matthews.


MILLIMETER.

PLATE 25

Iridophycus undulosum (Bory) S. et G.

Tetrasporic plants from Ushuaia, Fuegia, collected by Carl Skottsberg on the Swedish South Polar Expedition of 1901–1903. (In Herb. Mus. Botan. Upsaliense.)

Photo, W. C. Matthews.


MILLIMETER.
MUS. BOTAN.
UPSALIENSE
SVENSKA SYDPOLAREXPEDITIONEN 1901–03.
SER. N:R
D. 15/3 1902
CARL SKOTTSBERG.
DET.

PLATE 26

Iridophycus undulosum (Bory) S. et G.

Two specimens, representing the *Iridaea micans β ciliolata* Hook f. et Harv. from "St. Martin's Cove, Cape Horn," (in Herb. Kew!).

Photo, W. C. Matthews.

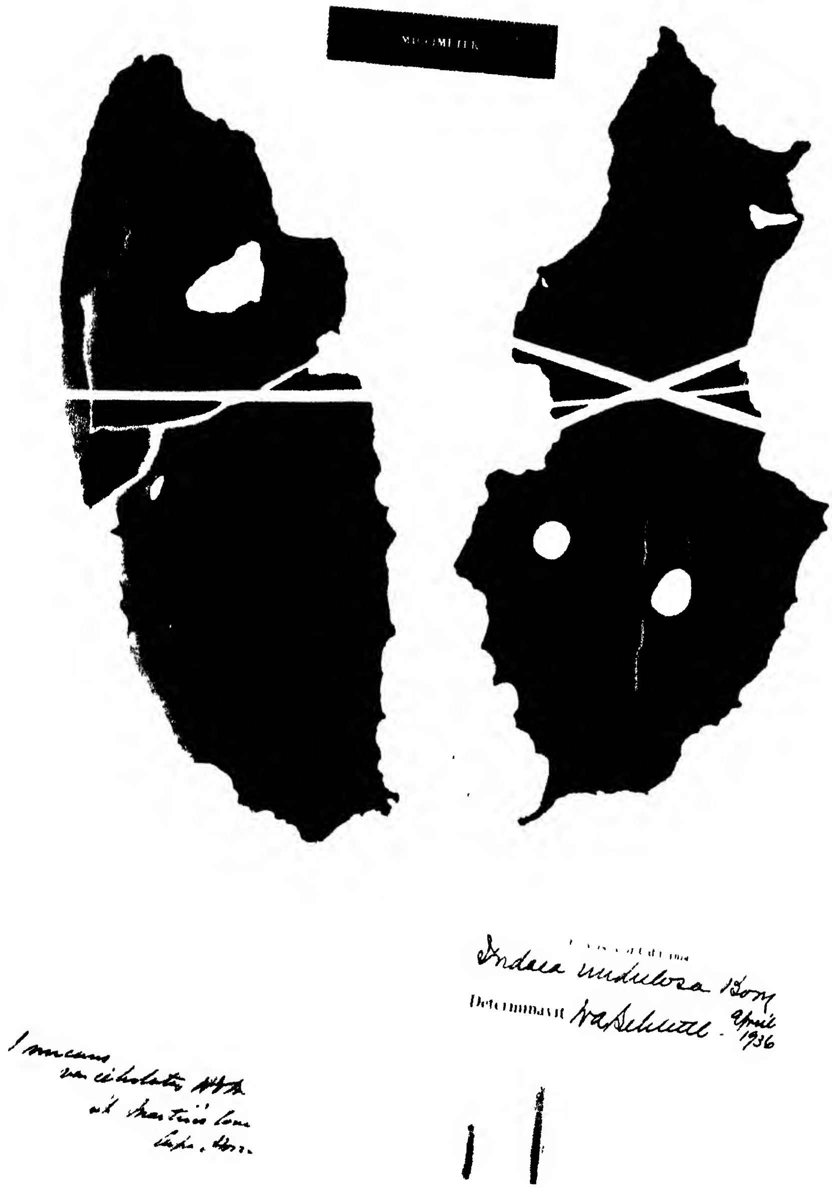

Iridaea undulosa Bory
Determinavit WA Setchell April 1936

PLATE 27

Gigartina papillosa (Bory) S. et G.

Type specimen, collected by Lesson in the Falkland Islands in 1825. (Herb. Bory in Mus. Paris!).

Photo, Cliche A. Cintract.


HERBIER
Lesson
MILLIMETER

PLATE 28

Gigartina Skottsbergii S. et G.

Young antheridial specimen, seen from the under surface, showing the eccentric primitive haptere surrounded by concentric circles of secondary hapteres. Valparaiso, Chile. (In Herb. N. Y. Bot. Garden.)

Photo, W. C. Matthews.

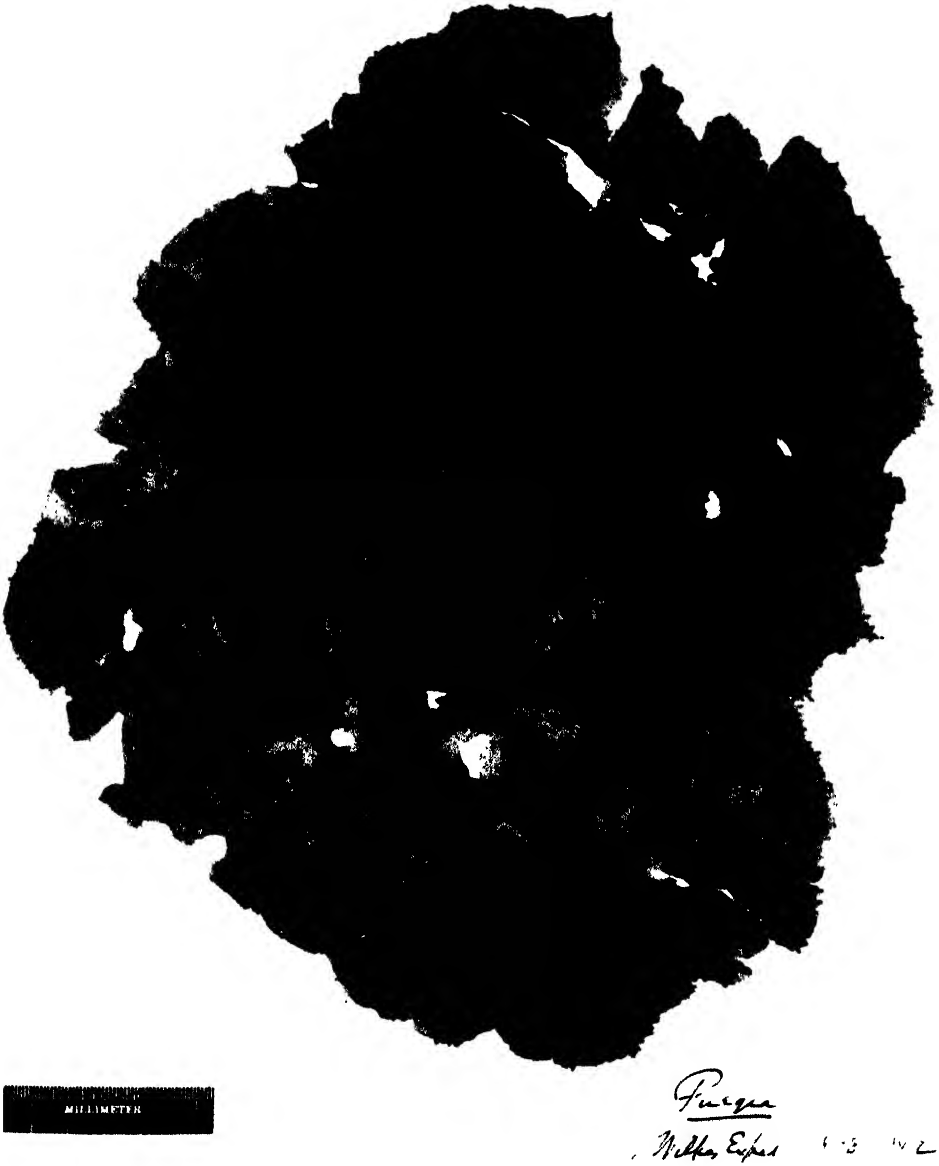

MILLIMETER.
Valparaiso, Chili

PLATE 29

Gigartina Skottsbergii S. et G.

View of upper surface of mature cystocarpic plant, collected by the U. S. Exploring Expedition of 1838–1842. (In U. S. Nat. Herb.)

Photo, W. C. Matthews.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NOTES ON SOME SYSTEMATIC RELATIONSHIPS IN THE GENUS PAEONIA

BY

G. LEDYARD STEBBINS, Jr.

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NOTES ON SOME SYSTEMATIC RELATIONSHIPS IN THE GENUS PAEONIA

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INTRODUCTION

THE GENUS *Paeonia,* although small in number of species, is very complex taxonomically. Many species are extremely variable under natural conditions, and this variability is greatly increased in the horticultural forms, which are discussed by most students of the genus. In view of the great horticultural interest of most of the species, the writer feels that any information which will help to clarify their relationships to each other and to the cultivated forms is of value. The activity of Dr. A. P. Saunders, of Clinton, N. Y., in gathering together most of the known species of the genus, in forms as near to the original wild ones as possible, and in making all possible hybridizations between them, has provided much information of this sort. During the past five years the writer has had the privilege of studying the plants of this living collection and therefore of comparing directly live plants of the various species, hybrids, and horticultural forms. Such comparison is of fundamental importance in the study of *Paeonia,* since the most important specific distinctions in floral characters are difficult or impossible to recognize in herbarium specimens. Also, a morphological and cytological study of Dr. Saunders' extensive series of hybrids has proved of great value in clarifying interspecific relationships. Hence the writer feels that the systematic knowledge gained through the study of the species and hybrids of the Saunders collection will help toward the final understanding of this most interesting genus.

MATERIAL AND METHODS

The origin of the plants of the species in the Saunders collection is discussed elsewhere (Saunders and Stebbins, 1938). Both a knowledge of their source and a comparison with herbarium specimens confirms the opinion that, with four exceptions, *Paeonia suffruticosa, P. albiflora, P. officinalis* and its relatives, and *P. corallina,* they are morphologically and genetically identical with or closely similar to the wild species which they represent. Besides studying the living plants, the writer has examined specimens of critical species in the United States National Herbarium (cited as US), the Gray Herbarium (G), the herbarium of the New York Botanical Garden (NY), borrowed through the generosity of their curators, to whom he wishes to express his gratitude, the herbarium of the University of California (UC), and the excellent private herbarium of Mediterranean plants of Dr. Hermann Knoche, at San Jose, California (Kn), through the kind permission of its owner.

In all the herbarium specimens studied, the critical floral characteristics have proved difficult or impossible to see. Most sheets bear only one flower, so that dissection is impossible without destruction of the specimen. Moreover, if the flower is mounted so as to show the sepal characteristics, those of the disk and follicles are obscured, and vice versa. In making specimens of the plants in the Saunders collection, the only satisfactory method was to dissect one of the flowers while it was fresh, and to press the parts separately. The sepals and petals were removed and flattened out, the group of follicles was split with a scalpel or knife, and a sufficient number of the stamens removed to expose at least part of the disk. When dry, the dissected floral parts may be placed in an envelope or pocket, or they may be mounted on a separate herbarium sheet, the parts being placed in order. Although time-consuming, this method is the only one that gives adequate information on the specimen collected, and the writer suggests that future collectors who may be interested in the genus should follow whenever possible this or some similar method.

Since in some of the species complexes, particularly that centering about *P. corallina,* a knowledge of the chromosome number is essential for an understanding of their systematic relationships, a method of inferring this in herbarium material has been of some value. This was measurement of the length of the guard cells of the stomata, a method used also by Matsuura (1935) with *Fritillaria,* Sax and Sax (1937) with several genera, and E. B. Babcock and Stebbins (1938) with *Crepis.* Since the length of the guard cells varies with the position of the leaf on the stem, being shorter in the higher leaves, care was taken to obtain the samples for measurement from corresponding parts of corresponding leaves. In this study the side of the terminal segment of the middle cauline leaf was the part selected. Although individual variation in size was found, the average size for the known diploids was always significantly lower than that for the tetraploids, the former ranging from 41 to 45μ, and the latter from 47 to 52μ. It was slightly larger in fruiting than in flowering specimens, so that when the maturity of the specimen was taken into account, an even greater contrast between the two types was found than is indicated by these figures.

MORPHOLOGICAL CRITERIA FOR THE SPECIES

Although four monographic treatments of *Paeonia* exist, those of Baker (1884), Anderson (1817), Lynch (1890), and Huth (1892), none has proved entirely satisfactory in the light of the present writer's observations. Emphasis has usually been placed on vegetative characteristics, or, among flower characteristics, on such criteria as pubescence of the follicles, color, and so on, none of which has proved significant in view of the hybridization work of Dr. Saunders. A review of the most important characters and their significance is therefore presented.

1. Great importance has been attached to *leaf character* by all four of the monographers of *Paeonia.* The resulting tendency to group together species with similar leaves has for the most part been successful in indicating natural

relationships, but in some groups, particularly the laciniate leaved forms related to *P. tenuifolia* and *P. anomala,* the great similarity of their leaves has led to the confusion of plants which in their floral characteristics are quite different from each other. Since the real relationships of these forms have been cleared up in large part by the cytogenetic studies of Saunders and Stebbins, a particular treatment of them is presented below. They are evidence that here, as in all other plant genera, leaf characteristics can be very misleading, and should be used with reservation.

2. The *character of the sepals* has proved the most valuable taxonomic character in the genus. Although overlooked by all the monographers, probably because of the difficulty of observing it in herbarium specimens, in which the sepals are usually hidden by the petals, this character was emphasized and well illustrated long ago for three Russian species by Pallas (1784). In the more primitive species of the genus, the sepals are indeterminate in number, and they all consist of two distinct portions, thus showing their homology to leaves. As has been described by Domin (1911) and Glück (1919, pp. 433–434), the proximal portion, corresponding either to the stipular sheath or to the petiole of a foliage leaf, more or less broadened and flattened, constitutes the sepal proper, while the distal part, corresponding to the blade, is a more or less leaflike terminal or subterminal appendage (figs. 2, A–5, A).

The increasing development of the proximal and reduction of the distal portion is in these species quite gradual, and even the innermost sepal possesses the vestige of a "blade" in the form of a small mucro at or near its apex. In the more advanced species, on the other hand, the number of sepals is smaller, the transition is more abrupt, and at least the innermost sepal lacks even the rudiment of a "blade" (figs. 10, A–13, A). In the most extreme species, *P. obovata* (fig. 13, A), the sepals are definitely three in number and are all nearly alike, none possessing a rudimentary "blade."

3. The *staminodial disk* has been used by Huth (1892) and others to separate the three subgenera, and is undoubtedly of value. The close resemblance, however, between the disks of *P. Delavayi* and *P. albiflora* (figs. 2, B; 3, B), which belong to different subgenera, reduces its significance somewhat. Within each subgenus there are differences in the disk which hold with some constancy, although they are of greater value in delimiting subspecies and varieties than in separating the main species complexes.

4. The *position of the mature follicles*—whether erect, spreading, or reflexed—is, as has been indicated by the monographers, of some importance. There is difficulty in using this character, however, because fully mature, completely fertile follicles, which alone can be used as a basis for comparison, are not encountered frequently enough in herbarium specimens.

5. The *pubescence of the follicles* has been given great weight by the monographers. This character is of use in delimiting many of the subspecies or varieties, but, unaccompanied by other differences, is as unreliable as characters of pubescence are in most other plant genera. For instance, although typical *P. albiflora* is stated by all the monographers to possess glabrous folli-

cles, and does for the most part, yet one natural variety (var. *trichocarpa* Bunge), and several horticultural forms including the well-known var. *Whitleyi major,* have the follicles tomentose. A similar difference is present among wild varieties of *P. anomala.*

6. The *shape of the summit of the ovary and the stigma* has been used by Finet and Gagnepain (1904) in their excellent treatment of the eastern Asiatic species, and has proved of value in the separation of species complexes as well as subspecies or varieties.

7. The *size, shape, and surface markings of the seeds,* as indicated in the key presented below, and illustrated in figure 1, are among the fundamental characters separating the three subgenera. Also of value is the peculiar wrinkling of the seed coat in many of the species having entire leaflets.

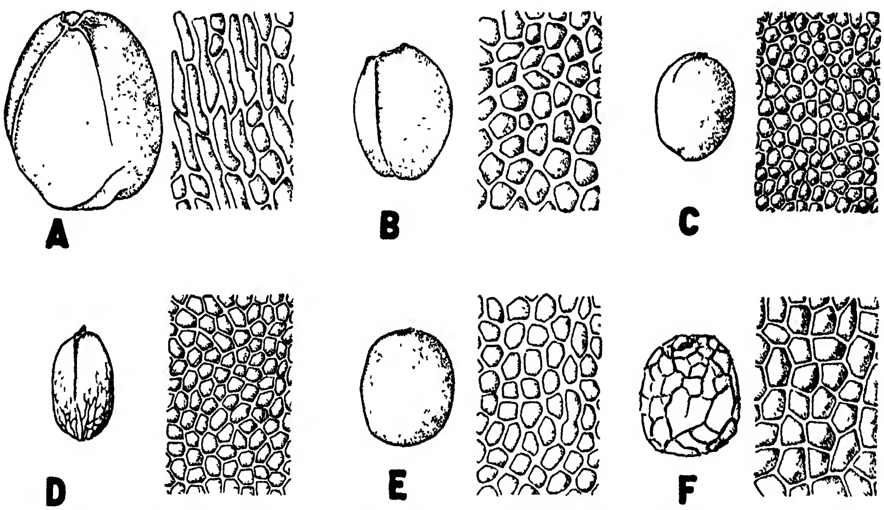


Fig. 1. The seeds (×2) and the surface markings on the seed coats (×100) of: A, *Paeonia Delavayi* var. *lutea;* B, *P. albiflora;* C, *P. anomala Woodwardii;* D, *P. tenuifolia;* E, *P. triternata Mlokosewitschii;* F, *P. obovata.*

CYTOLOGICAL EVIDENCE ON INTERSPECIFIC RELATIONSHIPS

A full account of the cytology of the species is presented elsewhere (Stebbins, 1938*a*). First, the basic chromosome number throughout the genus is five pairs; second, the species differ very little in the size and morphology of the chromosomes (Stebbins, 1938*a*); and third, there are a number of tetraploid species. These tetraploids, with 20 rather than 10 as their somatic chromosome number, are either closely similar morphologically to the diploids, such as the tetraploid forms of *P. corallina, P. corsica,* and the putative tetraploid of *P. Broteri,* or they show combinations of the characteristics of different diploids, as in *P. officinalis* and its relatives, *P. coriacea, P. Wittmanniana,* and *P. Willmottiae.* Only one tetraploid, *P. tomentosa,* diverges morphologically from any of the known diploids. These tetraploids account for much of the systematic difficulty in the genus. All of them intercross with ease, and many

give fertile or partly fertile progeny (Saunders and Stebbins, 1938). Furthermore, some of them are undoubtedly allopolyploids; that is, they are derived from hybrids between two diploid species by doubling of the chromosome numbers. These allopolyploids often include varieties which form an almost complete transitional series from one of their original diploid ancestors to the other. The origin of such series is presumably through segregation, caused by quadrivalent formation in the allopolyploids, and through the occasional production of fertile offspring from backcrosses. The exact methods are, however, not clear. Nevertheless, some of the diploid species which originally were probably quite distinct from each other have been linked together by a series of intermediate allopolyploid derivatives. These series are particularly well developed in the species with entire leaflets. The three diploid species, *P. triternata, P. Broteri,* and *P. Cambessedesii,* are distinct from one another, yet are apparently linked together by a series of allopolyploid derivatives, one of which is the true *P. corallina.* This group is a typical example of a polyploid complex as defined by Babcock and Stebbins (1938, pp. 55–57). A further discussion of this complex is given below.

In the key to the species of the subgenus *Paeon* here presented, the key letter setting off each tetraploid is marked with an asterisk. In these tetraploids variability and overlapping with the nearest diploids usually occurs.

THE THREE SUBGENERA OF PAEONIA

The following key gives what are, to the writer, the most salient characteristics of the three subgenera.

Key to the Subgenera of Paeonia

A. Disk conspicuous, one-third the length of the follicles, or more, scalloped or lobed; seeds large (10–15 mm. long), their surface dull, under a lens coarsely rugose with irregular longitudinal ridges. (Fig. 1, A)

- B. Plants herbaceous; petals shorter than to slightly longer than the sepals; disk wholly or partly divided into fluted or ridged lobes .... Subgenus *Onaepia*
- B. Plants woody at the base; petals definitely longer than the sepals; disk continuous, somewhat scalloped at the apex. (Fig. 2, B) .... Subgenus *Moutan*

A. Plants herbaceous; petals definitely exceeding the sepals; disk relatively inconspicuous or absent, less than one-third the length of the follicles at anthesis (except in occasional lateral flowers of *P. Emodi*), forming a continuous, undulate ridge, or somewhat scalloped; seeds smaller (5–11 mm. long), their surface more or less lustrous, under a lens minutely rugose through the elevated polygonal areas of the surface cells. (Fig. 1, B–F) .... Subgenus *Paeon*

Subgenus **Onaepia** Lynch, Jour. Roy. Hort. Soc., 12:433, 1890.
Sect. II. *Nearcticae,* Huth, Engl. Jahrb., 14:273, 1892.

This, the American subgenus of *Paeonia,* has been treated elsewhere (Stebbins, 1938*b*).

Subgenus **Moutan** Lynch, *ibid.,* 432.
Sect. I. *Palearcticae, Fruticosae,* Huth, *l. c.,* 272.

The shrubby habit of the species of this subgenus, as well as their restriction in range, suggest primitiveness and great age. The shrubby habit is not

necessarily a sign of primitiveness in plants, but it is certainly so in *Paeonia*, as has been demonstrated in the anatomical study of Kumazawa (1935). Furthermore, the species of this subgenus occur naturally only in the mountains of western China, a region noted for its wealth of old, "relic" species. Only two species are recognized, *P. Delavayi* and *P. suffruticosa*.

P. Delavayi Franch, Bull. Soc. Bot. Fr., 33:382, 1886.

The reduction of *P. lutea* Fr. to a variety of this species by Finet and Gagnepain (1904) is well supported by its behavior in the Saunders garden. It hybridizes freely, and most of the seedlings raised by Dr. Saunders from his original plants are mixtures of the two forms. Cytologically, the two pure varieties and the hybrids are all indistinguishable from one another. That hybridization also occurs naturally is evident from the intermediate flower color in some herbarium specimens; for example, between Muli and Kulu, Southwest Szechaun, *Rock* no. 24123 (UC).

P. Delavayi var. *angustiloba* Rehder and Wilson, Plantae Wilsonianae, 1, 318, 1913.

This is a weak variety, and its elevation to a species, *P. Potanini*, by Komarov (Not. Syst. Herb. Hort. Bot. Petr. II. 7. 1921) is wholly unjustified.

P. Delavayi is undoubtedly the oldest, most primitive species of the genus. It shows relationships with members of both of the other subgenera, resembling the American species of the subgenus *Onaepia* in the character of its seeds, and approaching them in the size and scalloping of its disk and the size and color of the petals, while it approaches *P. Emodi* and *P. anomala* of the subgenus *Paeon* in the character of its leaves and sepals, and resembles them in the shape of its follicles and stigmas.

P. suffruticosa Andr., Rehder (1913, 1920, 1925).

To Rehder's careful discussions of this species the present writer has nothing to add. In the peculiar triangular shape of its sepals, and particularly the extreme development and the thin, membranous texture of its disk, *P. suffruticosa* is definitely more specialized than *P. Delavayi*.

Subgenus **Paeon**, Lynch, *l. c.*, 434.
Sect. I. *Palaearcticae*, 1. *Herbaceae*, Huth, *l. c.*, 265.

This subgenus is much the largest and most widespread. The following key presents the species relationships as conceived at present by the writer, excluding those not sufficiently known to him. See also the key to hybrid forms, p. 259.

Key to the Species of the Subgenus Paeon

A. Midrib of the innermost sepals prominent and extending to the apex, where it is generally prolonged into a mucro or a linear appendage 1–15 mm. long; leaves ternate; primary divisions deeply lobed but never completely divided; stems bearing 2–5 flowers, except in forms of *P. anomala*.

B. Leaves not impressed veined, glabrous on both surfaces, their edges minutely scabrous-dentate under a lens; flowers erect; follicles (including the stigma) at anthesis 9–16 mm. high, erect or somewhat spreading at maturity............... *P. albiflora* Pall.

B. Leaves impressed veined, scabrous-pubescent on the main veins above, and sometimes on the margins and main veins beneath, the edge not scabrous; flowers more or less nodding; follicles (with stigmas) at anthesis 6–12 mm. high, distinctly spreading and sometimes nearly horizontal at maturity.

C. Terminal division of the largest leaves 5-lobed; disk 1.5–2.5 mm. high; follicle solitary or rarely 2; seeds 9–11 mm. long.....................*P. Emodi* Wall.

C. Terminal division of the largest leaves with 12–25 lobes; disk 0.2–1.2 mm. high; follicles 2–4; seeds 6–8 mm. long..............................*P. anomala* L.

A. Midrib of innermost sepal inconspicuous, not extending to the strongly rounded tip of the sepal; flower always solitary.

D. Roots fascicled; leaves once or twice ternate, the divisions cleft into a large number of lanceolate or linear lobes; sepals 6–9; stigmas erect or scythe-shaped............ *P. tenuifolia* L., *P. hybrida* Pall., etc. (see pp. 255–259)

D. Roots not fascicled; leaves (except in forms of *P. officinalis*) twice ternate, or the lateral divisions pinnately parted; ultimate leaflets entire or with lanceolate to elliptic lobes.

*E. Ultimate leaflets lobed; sepals 4–7, mostly 5 or 6................*P. officinalis* L.

E. Ultimate leaflets entire; sepals mostly 3–5.

F. Sepals 3–5, the outer one or two with a foliaceous appendage, markedly different from the inner in size and shape (figs. 10, A–12, A); petals obovate, the apex obtuse or rounded.

G. Follicles with an obtuse or rounded apex and a sessile stigma (figs. 10, A–11, A) becoming reflexed at maturity.

*I. Entire plant strongly suffused with a reddish anthocyanin pigment; leaves dark green, thick and coriaceous; innermost sepal 1½–2 times as long as broad; pubescence of follicles brownish, strongly persistent at maturity; mature seeds with a strongly wrinkled or reticulated seed coat.............. *P. corallina*, Retz vars. *P. Broteri* Boiss. et Reut.

*I. Anthocyanin pigment less noticeable, mostly pale pink, at least some part of the stem or leaf petioles greenish or yellowish; leaves dull, mostly bluish green; innermost sepal nearly or quite as broad as long; pubescence of follicles whitish, more or less deciduous at maturity; seed coat rough under a lens, but only slightly or not at all wrinkled at maturity............*P. triternata*

*G. Follicles attenuate at the apex (fig. 12, B) at maturity, erect, spreading, or somewhat reflexed; seed coat reticulate or wrinkled at maturity. (Fig. 1, F)

H. Leaves conspicuously hirsute beneath; flowers white or yellow............ *P. Wittmanniana*

H. Leaves glabrous or slightly pubescent beneath; flowers reddish or pinkish.

*I. Leaves not glaucous; follicles 20–30 mm. long at maturity; stigma curved from near the base...................................*P. corsica* Sieb. *P. Cambessedesii* Willk.

*I. Leaves strongly glaucous, follicles 35–50 mm. long at maturity; stigma elongate, the lower part straight.....................*P. coriacea* Boiss.

F. Sepals 3, unappendaged, subequal (fig. 13, A); petals elliptic, mostly acute; disk rudimentary; follicles glabrous, attenuate at the apex........*P. obovata* Maxim.

NOTES ON THE SPECIES OF THE SUBGENUS PAEON

(Figures 2–5, p. 253)

P. albiflora Pall.

This species, the common peony of cultivation, is well isolated genetically from all the other species. It crosses with great difficulty or not at all with the other diploid species (Saunders and Stebbins, 1938), and the hybrids between it and the tetraploid species are highly sterile triploids. There is therefore little reason to believe that any of the cultivated varieties of *P. albiflora* are derived through hybridization between it and other species. All these cultivated varieties so far investigated cytologically by Langlet (1928) and the present writer (1934, 1938*a*) are diploid, and in their meiotic behavior they resemble closely such species as *P. tenuifolia* and *P. Emodi,* forms of which nearly or quite identical with the wild species have been studied. Furthermore, they do not diverge from wild *P. albiflora* in any fundamental characteristics that bring them nearer to any of the other species, whereas all the hybrids produced by Dr. Saunders, using *P. albiflora* as one parent, are very different in many respects from any of its cultivated varieties (cf. Saunders and Stebbins, 1938). The following specimens of wild *P. albiflora* have been compared with specimens of the cultivated varieties.

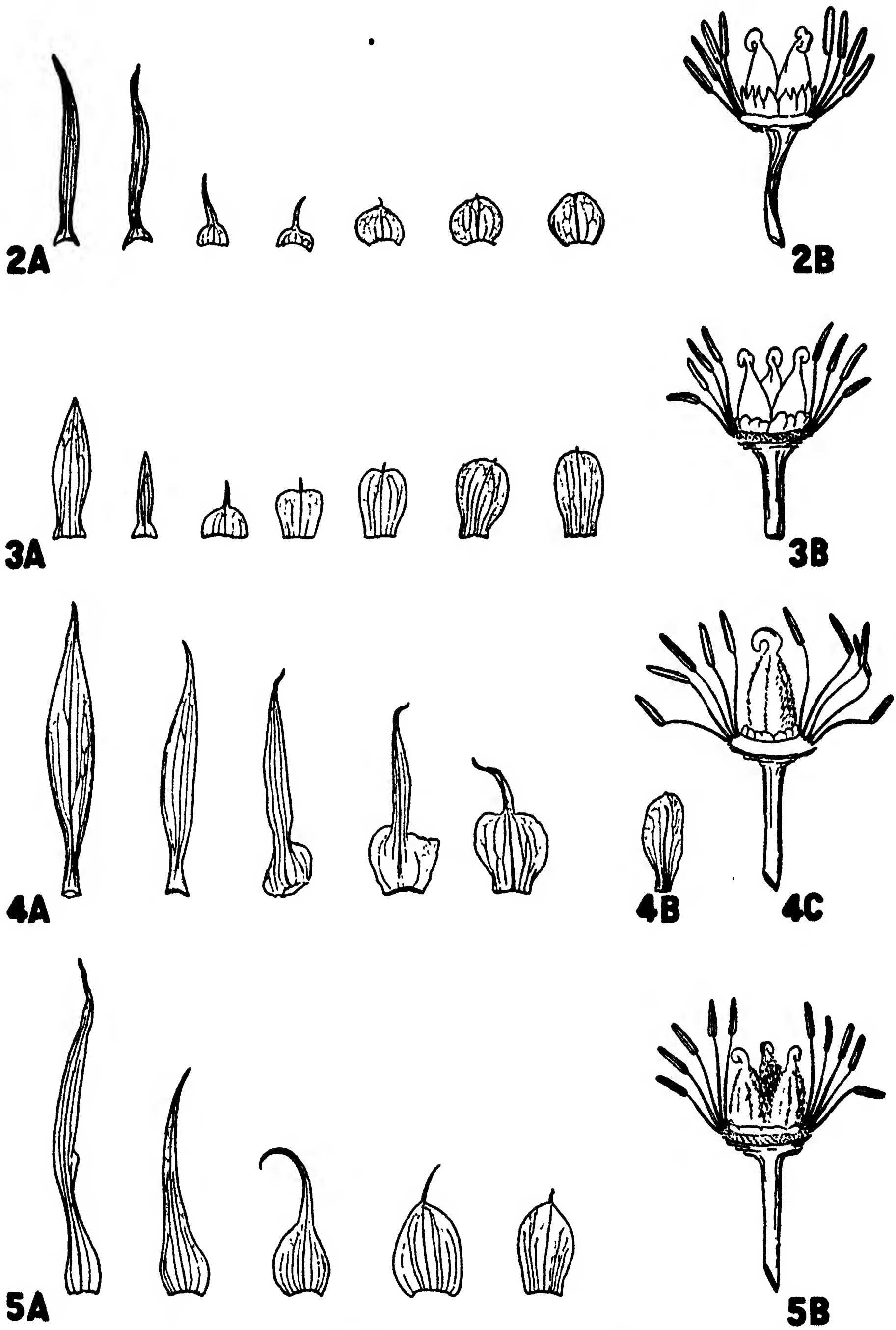
MANCHURIA: Jalartun, *P. H. Dorsett* no. 3491 (UC); near station Eho, North Manchurian Railway, *A. D. Voilykoff* in 1923 (UC). KOREA: Without locality, *K. S. Gilbert* no. 71 (UC). NORTH CHINA: Chai Tao Tzu Kou, near Jehol, *J. C. Liu* no. L654 (UC); Hsiao Wu T'ai Shan, Chihli, *Liu* no. L1734 (UC).

P. Emodi Wall., Cat. no. 4727.
P. anomala var. *Emodi* Huth, Engl. Jahrb., 14:269, 1892.

The reduction of this species to a variety of *P. anomala* is not in accord with the present study. The single follicle is a most distinctive characteristic of it, the disk is larger and more definitely toothed, and the seeds are markedly larger than those of any other species of the subgenus *Paeon.* Furthermore, the hybrid between it and *P. anomala "Beresowskii"* is sterile, although all hybrids between different forms recognized as belonging to *P. anomala* have so far proved fully fertile (Saunders and Stebbins, 1938). In its disk and seed characters it approaches *P. Delavayi* more nearly than does any other species of *Paeon,* and may in these respects be considered the most primitive species of its subgenus. Within its natural range, the Himalayan region, it is the only species occurring, and it is separated by about one thousand miles from the nearest *P. anomala.* Considerable variation occurs in the character of the innermost sepal (figs. 4, A; 4, B).

P. anomala L., Mant., 2:247, 1771.
P. anomala vars. *typica* and *nudicarpa* Huth, Engl. Bot. Jahrb., 74:269, 1892.
P. Veitchii Lynch, Gard. Chron., 46:2, 1909.
P. Beresowskii Komarov, Not. Syst. Herb. Hort. Pet., 2:5, 1921.
P. Woodwardii Stern, Jour. Roy. Hort. Soc., 56:76, 1931, *nomen nudum.*

This species is unusually variable, and includes a number of forms recently



Figs. 2–5. The sepals (2, A) and follicles (2, B) at anthesis of *Paeonia Delavayi* var. *lutea* (specimen from southwest Szechuan, *J. F. Rock* no. 24123) ; 3, A, B, the same of *P. albiflora* (specimen from Manchuria, *Krystofovich*) ; 4, A, C, the same, and 4, B, innermost sepal of *P. Emodi* (4, A, C, from cultivated plant, 4, B, specimen from W. Himalaya, *J. F. Duthie* in 1897) ; 5, A, B, the same from *P. anomala* (specimen from Ponoj, Russian Lapland, *J. Montell* no. 2121). 2, A–5, A, × ½ ; 2, B–5, B, × 1.

introduced into cultivation as distinct species. Although these differ among themselves, not only in vegetative but also in floral characteristics and in time of blooming, and breed more or less true to type, they intercross with ease, and such hybrids as have bloomed (to the date of the present writing) are completely fertile, and cytologically indistinguishable from their parents. Although Komarov with his description of *P. Beresowskii* (*l. c.*) gives a key to the members of this complex known to him, careful study of the series of specimens of *P. anomala* in the American herbaria has demonstrated to the present writer that this key is unworkable. Komarov distinguishes the Siberian *P. anomala* from the Chinese forms by its glabrous follicles, although Huth (1892) lists several specimens from Siberia under his var. *typica,* which is characterized by "carpellis junioribus pilosis"; moreover, a specimen from Russian Lapland—*Lapponia Ponojensis,* ad pagum Ponoj, *Montell* no. 212 (UC)—seen by the writer has follicles as tomentose as those of *P. Veitchii* and *P. Beresowskii* (fig. 5, A). Komarov distinguishes *P. Beresowskii* from *P. Veitchii* by its pale pink petals and gradually acuminate sepals, the petals of *P. Veitchii* being characterized as deep rose or purple, and the sepals as round-acuminate. However, among the numerous specimens of *P. anomala* from China seen by the writer, the two types of sepals have been found indiscriminately, and this difference does not seem to be correlated with any others. As for the difference in flower color, the notes on one collection, *Rock* no. 12235, from the Choni River basin, Kansu Province, read "flowers pink, white, or dark rose red," indicating that a complete series of variation from the flower color of *P. Veitchii* to that of *P. Beresowskii* may be found within the same colony. Another form of this species is that grown under cultivation as *Paeonia Woodwardii.* This is a dwarf plant, with sepals of the same shape as those of *P. Beresowskii,* but with rose-colored flowers, and small petals and anthers. It blooms two weeks earlier than *Beresowskii,* and about a week earlier than *Veitchii.* The size and early blooming habit of this form indicate that it is a high-altitude form, and its origin is the extreme northwest part of China, adjacent to Tibet (cf. Stern, *l. c.*). Among the herbarium specimens collected in this region by J. F. Rock are some which closely resemble this form, as well as forms transitional between it, *P. Beresowskii,* and *P. Veitchii,* similar to those which have been produced in the Saunders garden by hybridization. Since no indication has yet been found that any of these three forms (*P. Veitchii, P. Beresowskii,* and *P. Woodwardii*) has a definite geographic range, they seem best regarded at present as ecological variations of one polymorphic species, and hence without definite taxonomic rank. Since, however, they are grown under cultivation as distinct types, a key to them is here presented.

Key to Cultivated Forms of P. anomala

A. Innermost sepal rounded or notched at the apex; petals 3.5–5 cm. long; disk well developed, 1–1.2 mm. high.

B. Plants strictly 1-flowered; innermost sepal emucronate or with a short mucro 0.5–2 mm. long; follicles usually glabrous or at least glabrate at maturity. . . . . *P. anomala* (Siberian form)

B. Plants often 2–4-flowered; innermost sepal with a definite mucro 1.5–7 mm. long; follicles definitely tomentose at maturity..................*P. anomala "Veitchii"*

A. Innermost sepal more or less attenuate toward the well-developed mucro; petals 2–4 mm. long; disk relatively little developed, 0.8 mm. high or less.

C. Outermost sepal 6–7.5 mm. long; petals 3.5–4 mm. long, somewhat notched at the apex, cream color to pale pink; stigma cream color; plant flowering late (late May or early June in central New York).....................*P. anomala "Beresowskii"*

C. Outermost sepal 3.5–5 mm. long; petals 2–2.8 mm. long, entire at the apex, deep rose color; stigmas pink; plant flowering early (early to mid-May in central New York) ....*P. anomala "Woodwardii"*

The following are typical of the specimens of *P. anomala* seen by the writer:

RUSSIA: Lapponia Ponojensis, in vallicula rivuli ad pagum Ponoj, *Montell* no. 212 (UC). SIBERIA: Iter Ircutense ad fl. Lena et Kirenga, *N. I. Kusnezow* no. 114 (NY); prov. Semipalatinsk distr. Buchtarminsk, ad. fl. Ak-tei in fl. Buchtarma influet, *Tzumantzev* et *Takovlev* in 1814 (NY); Zaisank, southern Siberia, *F. N. Meyer* no. 754 (UC, G).

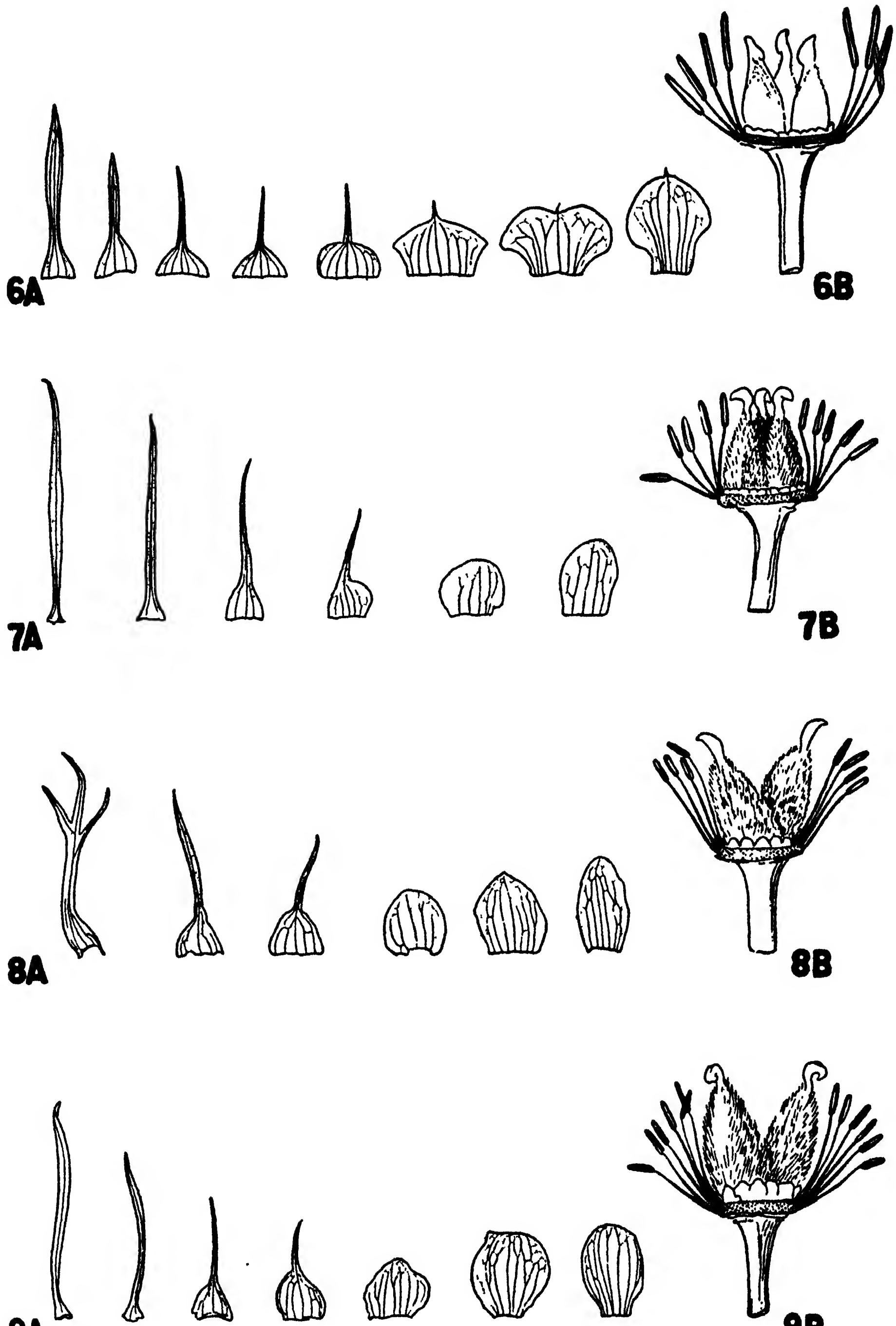
CHINA: Baurong to Tachienlu by way of Hadjaha, 2750–4000 m., Szechuan Province, *H. Stevens* nos. 261, 460 (NY); Sungpan Hsien, Szechuan, *Fang* nos. 4723, 6037 (G); Ma-pien Hsien, 3500 m., Szechuan, *Wang* no. 22930 (G); T'ao River basin, Choni River basin, common up to 10,000 ft. (3030 m.), Kansu Province, *J. F. Rock* no. 12235 (NY); T'ao River basin: Valley-Kwadjaki, Choni, alt. 9500 ft. (2880 m.), Kansu, *J. F. Rock* no. 12276 (G).

P. anomala is most closely related taxonomically to *P. Emodi,* and less closely to *P. albiflora.* The great difficulty with which *P. albiflora* crosses with any of the forms of *P. anomala,* and the very sterile morphologically abnormal hybrids resulting from this cross (Saunders and Stebbins, 1938), suggest that the genetic relationship between the two species is more remote than is indicated by their external appearance. In the shape of its leaves, sepals, and follicles, *P. anomala* somewhat resembles *P. Delavayi,* and along with *P. Emodi* it may be considered the most primitive species of the subgenus *Paeon.*

P. TENUIFOLIA L., P. HYBRIDA PALL., AND THEIR RELATIVES

(Figures 6–9, p. 256)

One set of hybrids produced by Dr. Saunders explains at least in part the problem of *P. hybrida.* Pallas (Flora Rossica, 2:94, t. 86, 1784) originally described and illustrated as this species a plant which he found growing in the garden between plants of *P. anomala* and *P. tenuifolia,* and which was apparently derived from a seed produced by the latter. Since the plant was sterile, he at first believed it to be a hybrid between these two species. Later a plant apparently identical with it, but fertile, was found growing wild in southeastern Russia and Siberia, and on the basis of this discovery Pallas considered *P. hybrida* a good species. Since then *P. hybrida* has been considered by some authors a variety of *P. tenuifolia,* by others (Huth, 1892) a variety of *P. anomala,* and by still others (Krylov, 1931) a good species. *P. intermedia* C. A. Meyer ex Ledeb., Fl. Alt., 2:277, is probably synonymous with *P. hybrida.*



Figs. 6–9. The sepals and follicles of 6, *P. Smouthi,* cultivated plant; 7, A, *P. tenuifolia* × *anomala* (typical); 7, B, *P. tenuifolia* × *anomala* Woodwardii, both hybrids grown by A. P. Saunders; 8, *P. tenuifolia* "hybrids" (tetraploid) from cultivated plant; 9, × *P. Saundersii* (*P. tenuifolia* × *triternata*), from hybrid plant grown by A. P. Saunders. 6, A–9, A, × ½; 6, B–9, B, × 1.

The original belief of Pallas about the plant discovered in the garden at Leningrad has been confirmed by the repetition of the cross *P. tenuifolia* × *P. anomala*. The F_1 plant of this cross agrees exactly with the description and illustration of Pallas, and, like the plant described by him, is almost completely sterile. It is, furthermore, identical with specimens of wild *P. hybrida* from western Siberia and Turkestan, except that the latter have apparently completely fertile pollen.

Several other plants must be considered in this connection. One was received by Dr. Saunders from Barr and Sons (London, Eng.) as *P. tenuifolia* var. *hybrida*. Another, received from Lemoyne as *P. tenuifolia* var. *latifolia*, is identical with it. Both are fertile tetraploids, and therefore quite different cytologically from true *P. hybrida*, and they differ also from both *P. tenuifolia* × *P. anomala* and the wild *P. hybrida* in their leaves, which are pubescent beneath; in their inner sepals, which are much larger; and in their follicles, which at anthesis are also much larger. The stomata of these plants are, like those of all tetraploid species of *Paeonia*, larger than those of the diploid species and hybrids (average length of guard cells, 49–50μ). In the specimens of wild *P. hybrida* cited above, the length of the guard cells (average 44–45μ) is the same as that in typical *P. tenuifolia*, and indicates that they are diploid.

No specimens of a wild plant corresponding to the tetraploid "*P. tenuifolia* var. *hybrida*" have been seen. Of the origin of this tetraploid there are two possibilities: either it is a wild form of southern or southeastern Russia, and as such is different from the plant of Turkestan and Siberia, or else it is of unknown garden origin.

P. Smouthi Van Houtte, Hort. Universel, 4:274, 1845.

Two other forms similar to the members of this group are often erroneously named *P. anomala*. One, *P. Smouthi*, is a sterile hybrid of known garden origin between *P. albiflora* and *P. tenuifolia*, and resembles closely some of the F_1 plants of the same cross produced by Saunders (cf. Hicks and Stebbins, 1934; Saunders and Stebbins, 1938; Stebbins, 1938*a*). It was first advertised by Barr & Sons as *P. anomala intermedia*, and later as *P. anomala typica*, and was also distributed by the Old Farm Nurseries, Booskop, Holland, as *P. anomala*.

P. tenuifolia × triternata.

The other form is represented in the Saunders garden by four clones, all received as *P. anomala*, and several seedlings of known hybrid origin. Three of these clones were received from Barr & Sons, the first originally under the name *P. anomala*, but later changed (*in litt.*) to *P. anomala intermedia*, the second as *P. anomala insignis*. The fourth clone was purchased from a German firm as *P. anomala*.

× *Paeonia Saundersii* hybr. nov. (*P. tenuifolia* × *triternata*). Planta ca. 5 dm. alta; segmenta foliarum laciniato-pinnatifida, supra glabris, subtus minute et sparse pubescentibus vel glabris; sepala 6–7, extimum foliaceum, integrum et linearo-lanceolatum vel pinnatifidum cum 3–5 lobis lanceolatis,

intimum rotundatum, emucronatum; petala obovata; discum 1–1.7 mm. altum; follicula (cum stigmo) ad anthesin 14–19 mm. longa, erecta, dense tomentosa, ad maturitatem horizontaliter patentia, 25–30 mm. longa; stigma plus minusve recurvata.

Plant 5 dm. high; divisions of the leaves laciniate-pinnatifid, the lobes linear-lanceolate, 3–12 mm. broad, glabrous above, minutely and sparsely pubescent below or glabrous, acute or acuminate; sepals 6–7, the outermost entire and linear-lanceolate or pinnatifid with 3–5 lanceolate lobes, the innermost rotund, cup-shaped, emucronate, 6–7 nerved, 20–25 mm. long and 18–25 mm. broad; petals obovate, 3.5–5.5 mm. long, 2–5 mm. broad, red, pink, or yellowish pink; anthers 3–5 mm. long; disk 1–1.7 mm. high, somewhat undulate; follicles (with stigma) at anthesis 14–19 mm. long, erect, densely tomentose, at maturity horizontally spreading, 25–30 mm. long; stigma more or less recurved.

The natural occurrence of this hybrid has been reported by Maleev (1937). In cultivation, forms apparently identical with those described by Maleev are distributed erroneously as *P. anomala,* and under the following names given to various clones by Barr & Sons: *P. anomala* "Peter Barr," and *P. anomala* "insignis." Later Barr & Sons (*in litt.*), following the advice of the late Dr. Otto Stapf, designated these forms with tomentose follicles as *P. anomala intermedia.*

From true *P. anomala* this hybrid differs conspicuously in its narrower, more numerous leaf segments; in its sepals, the innermost of which in *P. anomala* is much less conspicuously cup-shaped, and is either mucronate or with a conspicuous midrib; in the color of its flowers, which in *P. Saundersii* have the red of *P. tenuifolia* more or less evident, and lack the magenta shades most characteristic of *P. anomala;* and in its follicles, which in *P. Saundersii* are larger both at anthesis and (notwithstanding their sterility) at maturity.

P. hybrida (*P. intermedia*) is much more like *P. Saundersii,* and superficially they are very difficult to distinguish from each other. In *P. hybrida,* however, the leaves are more finely dissected than in *P. Saundersii,* and their pubescence is either absent or confined to the main veins, both above and below, and to the margins; in *P. Saundersii* pubescence is distributed evenly, though sparsely, over the undersurface. The former type of pubescence is characteristic of forms of *P. anomala,* the latter of *P. triternata.* The flowers of *P. hybrida* are smaller in all their parts, and the disk is absent or rudimentary, the follicles are less spreading at maturity (in both the sterile garden hybrid and the fertile wild form), and the stigma is less strongly recurved.

This hybrid has been produced in three different ways by Dr. Saunders, and several plants of it of known origin are in existence. The first two series are reciprocal hybrids between *P. tenuifolia* and the yellow-flowered form of *P. triternata, P. Mlokosewitschii* (for a discussion of this species, see below). They are identical with the forms distributed as *P. anomala,* except that their flowers are not red, but salmon pink or somewhat yellowish. The third group, which has only recently come into bloom, has as its parents the same clone of *P. tenuifolia* as the other two, and a plant of typical *P. triternata* received (as *P. corvallina*) from Correvon et C^ie^. This differs from the other plants men-

tioned in that its leaves are completely glabrous below, and its flower (as is characteristic of young plants blooming for the first time) is somewhat smaller. The foregoing description includes all the plants mentioned.

Since this hybrid has not only been found several times in the wild state (cf. Maleev, *l. c.*), but is also not infrequent in cultivation, and is, in the gracefulness of its foliage and the size and color of its flowers, one of the finest of the single peonies, a name for it seems to be desirable. It is with great pleasure that I dedicate it to Dr. A. P. Saunders, who first produced it from known parents and through whose labors so much has been learned both horticulturally and scientifically about this genus.

In order to clarify the distinctions between the various species, hybrids, and horticultural forms described above, a key to them is presented:

KEY TO P. ANOMALA, P. TENUIFOLIA, AND RELATED FORMS

A. Innermost sepal mucronate, or at least with a strongly developed midrib which continues to its apex (figs. 5, A; 6, A); follicles glabrous or short-pubescent; stem often 2–4-flowered.

B. Leaves scabrous-pubescent on the midrib and often on the veins above, impressed veined, smooth and shining beneath, the lobes of the leaflets lanceolate or elliptic; petals 2.5–4.5 cm. long; plants with fertile pollen and always producing seed....... *P. anomala*

B. Leaves glabrous throughout, not impressed veined, lobes of the leaflets lance-linear; petals 5–6 cm. long; plants with partly sterile pollen, rarely producing seed........ *P. Smouthi* (*P. albiflora* × *tenuifolia*)

A. Innermost sepal rounded, its midrib indistinct and never extending to the apex; follicles always pubescent; flower always solitary.

C. Roots fusiform; leaves glabrous below; follicles 9–13 mm. high at anthesis; disk 0–1 mm. high.

D. Leaf lobes narrowly linear, 1–2 mm. broad, very numerous, dorsal edge of the erect stigma straight except at the slightly recurved apex; disk absent....*P. tenuifolia*

D. Leaf lobes 2–5 mm. broad, less numerous; stigmas more or less recurved and scythe-shaped; disk 0.5–1 mm. high.............................*P. hybrida*

C. Roots not fusiform; leaves generally pubescent below; follicles, including the stigma, 13–19 mm. high at anthesis; disk a continuous fleshy ring 1–1.7 mm. high.

E. Leaves strongly pubescent below, the pubescence in living specimens visible to the naked eye; innermost sepal 12–17 mm. broad; follicles at anthesis 13–14 mm. high; partly fertile tetraploids with good pollen... ....*P. tenuifolia "hybrida"*

E. Leaves minutely short-pubescent below, the pubescence visible only under a lens, and sometimes almost invisible in dried specimens; innermost sepal 18–25 mm. broad; follicles at anthesis 14–19 mm. high; sterile hybrid........× *P. Saundersii*

Paeonia officinalis L., Sp. Pl. ed., 2:747, 1762.

The relationships of this species and its relatives are far from clear, although their behavior in the garden indicates that all the forms referred by Huth to *P. peregrina* as well as to *P. decora* are interfertile and intergrade freely, so that they all belong to the same species. A further treatment of the species will be presented in a later publication in which evidence concerning its probable origin will be presented.

P. tomentosa Stapf, Bot. Mag., 155, Tab. 9249, 1931.

The writer has seen only the plants in the Saunders collection, which agree closely with the original description and illustration. In its rugose, impressed veined leaves, large, brown-tomentulose sepals, and remarkably broad, almost reniform petals it differs from any other species known to the writer, although in the absence of a disk and the shape of the follicles and stigmas it agrees with *P. corallina* and *P. Broteri.* It is the earliest to bloom of all the species in the Saunders collection, and flowers about three weeks earlier than the other tetraploid forms of the *corallina* series. It forms sterile hybrids with *P. Wittmanniana,* which is to be expected in view of the great difference between the two species in the shape of the sepals, petals, follicles, and stigmas.

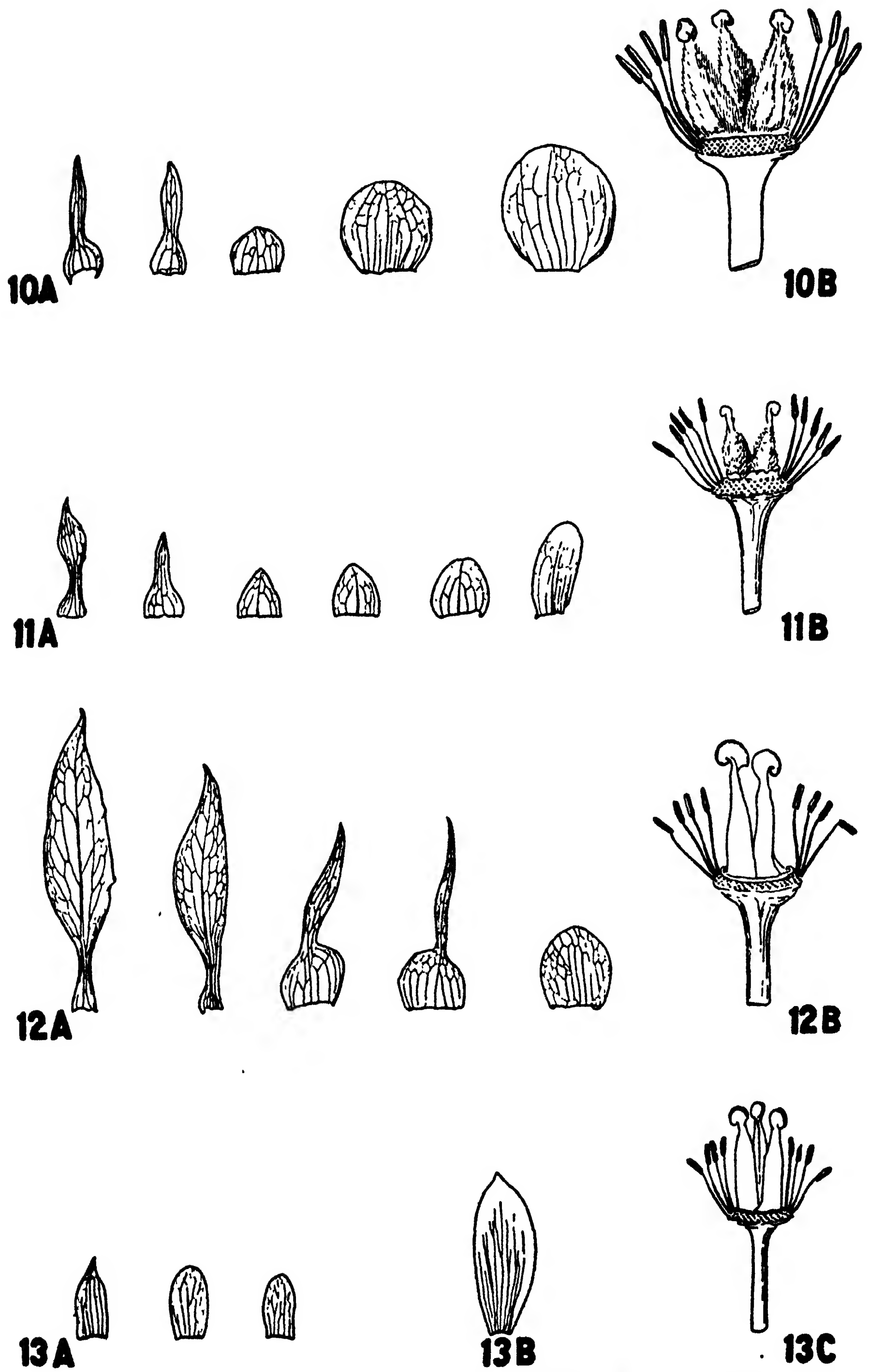
Notes on P. Corallina Retz, P. Russii Biv., and P. Broteri Boiss. et Reut.

(Figures 10–13, p. 261)

The interrelationships of the whole group of species with entire leaflets and rounded, emucronate sepals are so complex, and have been so much complicated by hybridization in cultivation and the description of species on insufficient characters, that an adequate treatment is impossible without an extensive study of the specimens in the various European herbaria and the species in their native habitats. However, the cytogenetic studies have revealed some facts which may be of help to an eventual understanding of this complex. There are, besides the very distinct *P. tomentosa,* at least four groups of species that are represented by diploid forms which are quite distinct from each other, that apparently cross with difficulty (so far as the experimental evidence goes), and that are well isolated from each other geographically and therefore must represent distinct species. These diploids are *P. Broteri, P. triternata, P. Cambessedesii,* and *P. obovata.* There is also a large number of tetraploid forms which in their morphological characteristics and in some measure their geographic distribution bridge the gap between the diploid forms. At present the writer is not certain whether these tetraploids form a series of species morphologically distinct from the diploids or whether there is so much intergradation that they must be merged with their nearest relatives among the diploids. If it is the latter that is so—and it seems the more probable situation, so far as judgment is based on the writer's present knowledge—at least one of the tetraploids, *P. corallina* Retz (the older name), must be taken as the nomenclatorial type of the group which it represents. However, the names of the diploids are retained at present, since they are better characterized by their original descriptions, and their relationships with each other are better understood.

P. Broteri Boiss. et Reut., Diagn. Pl. Nov. Hisp., 4.

The first group of species centers about the diploid *P. Broteri,* a characteristic form of southern Spain. It is characterized by a strong development of reddish anthocyanin pigment or its vegetative parts; completely glabrous leaves, the largest of which are pinnately rather than ternately compound,



Figs. 10–13. The sepals and follicles of 10, *P. triternata;* of 11, *P. Broteri;* of 12, *P. corsica;* of 13, A, and 13, C, *P. obovata;* of 13, B, petal of *P. obovata*. All from cultivated plants. 10, A–13, A, × ½; 10, B–13, B, × 1.

and have narrowly elliptic leaflets 2½–3 times as long as broad; elongate sepals, the innermost 2–2½ times as long as broad; the disk obsolete or nearly so and completely covered with tomentum; the follicles densely brown-tomentose, abruptly contracted at the apex to the broadly scythe-shaped stigma, and the seed coat strongly reticulate-wrinkled. The following specimens are characteristic:

SPAIN: Sierra de Segura, *E. Bourgeau* in 1850 (G, Kn); Grazalema, Andalusia, E. Reverchon (NY). PORTUGAL: Prope Ingote non procul Conimbria, *A. Moller* no. 1510 (G, Kn).

Within the same region there occur very similar forms which, on the basis of their stomatal size, are apparently tetraploid. These pass gradually into forms corresponding with *P. Russi* Biv., in which the leaves are hairy below and are never pinnate, the leaflets are shorter and broader, and the sepals are somewhat shorter. Although no chromosome counts have been obtained, evidence from stomatal measurements indicates that both diploid and tetraploid races of the Russi type exist. The following may be cited:

SPAIN: Cerro de Machotte, prope Escurial, *M. Winkler* in 1876 (Kn) (2n = 20?); Sierra de Gredos, *Bourgeau* in 1863 (Kn) (2n = 20?). PORTUGAL: Serra de Arrabila, *J. Daveau* in 1879 (G, Kn) (2n = 20?). SICILY: Palermo, *H. Ross* no. 304 (G, NY, Kn) (2n = 10 and 2n = 20?); in nemoribus, *Incono* no. 551 (Kn) (2n = 20?). SARDINIA: reg. centr. or., in Monte Oliena, *C. Forsyth* in 1884 (G, Kn) (2n = 10?). CYPRUS: In sylvis Montis Troados, Sintenis et Kigo no. 854 (Kn) (2n = 20?). ASIA MINOR: North of Beilan, Syria, ex herb. Postian apud Colleg. Syriens Protestants no. 219 (US) (2n = 10?); Armenia Rossica, Szovitz (G, US) (2n = 10?).

Finally, there is a series of plants, all of them tetraploid, which combine the characteristics of *P. Broteri* and *P. Russi* with those of *P. triternata,* and which also approach *P. corsica* and its relatives. These fit the original description of *P. corallina* Retz. (Obs., 3:34, 1783) as well as Huth's (1892) characterization of *P. corallina* var. *typica.* They have the reddish stems and leaf veins of *P. Broteri* and *P. Russi,* though in less marked form; the leaves are ternate, and the leaflets are pubescent along the veins below; the sepals are similar in shape to those of *P. Russi,* and mostly small (innermost sepal 15–25 mm. long by 12–16 mm. broad). The disk is usually little developed and is always tomentose, and the follicles, though less strongly tomentose than in *P. Broteri* and *P. Russi,* are definitely yellowish and are abruptly contracted at the apex. The following specimens may be cited:

FRANCE: Les Montils, près Blois, Loire-et-Cher, *L. Mathonnet* no. 372 (G, Kn). Monts de Cagne, Bonifacio, Corsica, *G. Desplantes* in 1933 (G). SICILY: In sylvaticis Hebrodum, Madonie, *Leresche* in 1844 (US); prov. Sassari, silva de Bullei, 600–700 m. SARDINIA: *Fiori* and *Tiana* no. 1853 (G).

P. triternata Pall., Nov. Act. Petr., 10:312.
P. Mlokosewitschii Lomak, Trud. Tifl. Bot. Sod., 2:282, 1897.

The next series is the group centering about the Crimea and the Caucasian region, all of them diploids. These include *P. triternata* Pall. and *P. Mlokose-*

witschii Lomak, two forms which are perfectly interfertile and undoubtedly belong to the same species. They are characterized by the weakly developed anthocyanin pigment on their stems and its absence from their leaves; twice ternate leaves whose undersurface is minutely and evenly pubescent; large sepals (the innermost 2.7–3.5 cm. long and nearly as broad), which are strongly veiny; a well-developed, glabrous disk; and follicles which are densely but rather shortly white-tomentose and shaped like those of the *Broteri-corallina* complex. No specimens have been seen by the writer which would enable him to tell whether or not the yellow-flowered, narrow-leaved form, *P. Mlokosewitschii* Lomak, is a distinct geographic segregate and hence entitled to varietal or subspecific rank. The following specimens are typical of *P. triternata:*

RUSSIA: Prope Jaltam, Tauria, *T. Wankow* in 1910 (US); prope Lenkoran, Azerbaijan, *R. F. Hohenacker* in 1838 (G, US).

P. CAMBESSEDESII, P. CORSICA, P. CORIACEA, AND P. WITTMANNIANA

These species, with the follicles attenuate at the apex into an elevated stigma, and therefore of the same shape as those of *P. albiflora* and *P. obovata,* but with the leaves and sepals characteristic of *P. corallina,* are apparently closely related, although most of them are widely separated geographically. The only diploid represented is *P. Cambessedesii* Willk. (Fl. Hisp., 3:976) (cf. Dark, 1936), a native of the Balearic Islands. The only characteristics known to the writer which distinguish this species from the more widespread tetraploid form, *P. corsica* Sieb (ex Tausch., Flora, 11:88, 1828) are the deep purple color of the under side of the leaves, the larger number of follicles (5 in *Cambessedesii,* 2–3 in *corsica*), and the strongly rather than moderately wrinkled seed coat. No herbarium specimens of this type with a stomatal size indicating the diploid number have been seen. The following are all apparently tetraploid. Those from Majorca agree well with descriptions of *P. Cambessedesii,* the others with *P. corsica.*

MAJORCA: Ombre, rare, *Knoche* no. 116 (Kn); Faro Formentor, *Knoche* no. 122 (Kn). CORSICA: Serra de Scopamène, par Sartène, *E. Reverchon* no. 218 (as *P. Russi,* Kn). SARDINIA: Monte Limbardo, arr. de Tempio, *E. Reverchon* no. 291 (part, as *P. Russi,* Kn). RHODES: Collines du Mt. San Elio près de Salakos, *E. Bourgeau* in 1870 (part, as *P. corallina,* US).

P. coriacea Boiss., Voy. Esp., 14: t. 3, 1838.

This plant, from Spain and Morocco, appears very distinct in its glaucous habit, large follicles, and elongate stigmas, but may be only a well-marked variety of the preceding. The following specimens, all apparently tetraploid, have been seen:

SPAIN: Puerto del Viento, Sierra de Ronda, *E. Bourgeau* in 1849 (G). Prov. Malacitana, Regnum Granatense, *Huter, Porta* et *Kigo* no. 862 (Kn). MOROCCO: Djebel Cilhatin, prov. de Demnat, *Ibrahim* in 1879 (G); Yebel Tisuka, alt. 1800 m., *Font Quer.* no. 105 (as *P. mascula* var. *maroccana,* UC); supra Azrou, 1500 m., *R. Maire* in 1933 (UC). ALGERIA: Djebel Majus, 1600 m., *Reverchon* no. 324 (Kn).

P. Wittmanniana Hartwiss (ex Lindl. Bot. Reg., n.s., 9: t. 9, 1846); Stev. *in* Bull. Soc. Nat. Mosc., 21:2, 275, 1848.

P. Willmottiae Stapf., Bot. Mag., 142: t. 8667, 1916.

Finet and Gagnepain (1904) first pointed out that the plants of western China then passing as *P. obovata* Maxim. were actually indistinguishable from *P. Wittmanniana* Stev. of Persia. Stapf did not take their publication into account in his description (*l. c.*) of these Chinese plants as *P. Willmottiae,* nor did he compare his proposed species with *P. Wittmanniana,* although he rightly pointed out its distinctness from true *P. obovata* of northeastern China, Manchuria, Korea, and Japan, a point on which Finet and Gagnepain were doubtful. The only distinction between the Persian and Chinese forms which the writer can find is in the color of the flowers, which in *Wittmanniana* is pale yellow, in *obovata,* white. The localization of *P. Wittmanniana* in northern Persia and western China gives it the most extraordinary range of any species of the genus. This is made even more remarkable by the close affinity of *P. Wittmanniana* not only to *P. obovata,* but also to *P. corsica* and *P. coriacea* of the Mediterranean region. Phylogenetically, these species are the most advanced of the genus. The strictly 1-flowered habit, the reduced number and specialized shape of the sepals, and the wrinkling of the seed coat are all specializations not found in the more primitive species of the subgenus, such as *P. anomala* and *P. albiflora.* Furthermore, their tetraploid nature indicates that they are of more recent origin than other species, such as *P. triternata* and *P. obovata,* which have similar morphological specializations. Nevertheless, their disrupted ranges and localized occurrence suggests that even these species are very old chronologically, and therefore that the entire genus is an extremely old one. The following specimens are typical of *P. Wittmanniana:*

PERSIA: prope Siaret, in montis prov. Astrabadensis, *Bunge* in 1858 (G). CHINA: Hupeh, without definite locality, *A. Henry* nos. 847, 5365 A (G, NY); western Hupeh, *E. H. Wilson* no. 359 (G). Shin Shan Hsien, Hupeh, *W. Y. Chun* and *S. S. Chien* no. 835 (UC); Nanchuan-hsien, Szechuan, 1820–2120 m., *W. P. Fang* no. 1081 (G).

P. obovata Maxim, Prim. Fl. Amur., 29, 1857.

P. japonica Miyabe and Takeda, Gard. Chron., 48:366, 1910.

This species is a most distinctive one, not only in its low habit, small flowers, and slender peduncles, but also in its floral characteristics. The sepals, reduced to three in number and completely devoid of foliaceous appendages, are the most advanced in the genus. The narrow, acute petals also show specialization in being more sharply differentiated from the sepals than in most of the species. Phylogenetically, *P. obovata* may be considered the most advanced of all the diploid species of *Paeonia.* The characters on which Miyabe and Takeda separated the Japanese form from that of Korea, northern China, and Manchuria have not been found to hold. The stigma illustrated in figure 13, C is from Japanese material, but is quite similar to that found in Manchurian and Korean specimens, some of which have the undersurface of the leaves

glabrous, a characteristic used by its authors to distinguish *P. japonica*. The following specimens are typical:

CHINA: Chihli, without locality, *Chanet* in 1918, no. 30 (G); near eastern tombs Hopei (Chihli), *K. M. Liou*. MANCHURIA: Inter fluv. Tsutar et Talagacz, *V. Komarov* no. 654 (G, NY). KOREA: In silvis Hallaisan, U. Faurie no. 1711 (UC). JAPAN: Sapporo, *K. Sugiyama* in 1885 (NY); southern Hokkaido, without definite locality, *W. P. Brooks* nos. 437, 551 (UC).

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NEW SPECIES OF MELANOPHYCEAE FROM THE PACIFIC COAST OF NORTH AMERICA

BY

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Ectocarpus ensenadanus sp. nov.

Plate 30, figure 1

Frons diminutiva, per filamentos repentes affixa, 3–6 mm. alta, sparse et invicem ramosa; incremento intercalari, primo meristemate 14–20 cellulis prope apicem obtuse-conicem, aetate provecta, spatium definitum cellularum multarum infra pilum apicale composito; cellulis cylindricis, 18–20μ diam., per filamenta tota equalibus, longioribus 2–4-plo diam.; cellulis meristematicis haplo aut tertio brevioribus quam diam.; chloroplastis fenestrato-taeniaeformibus; gametangiis sparsis, sessilibus aut 1–2 cellulo-pedicellatis, fusiformibus usque ad brevi-conicis, usque ad 40μ diam. max.; zoosporangiis adhuc non visis.

Fronds diminutive, attached by branched creeping filaments, 3–6 mm. high, sparsely and alternately branched; growth intercalary, at first the meristem composed of 14–20 cells at the apices, later occupying a definite section of the filament many cells back of the hairlike apical portion; cells cylindrical, 18–20μ diam., approximately the same diameter throughout the filament; 2–4 times as long as the diameter; meristematic cells ½–⅓ as long as the diameter; chromatophore a fenestrate band; gametangia sparse, sessile or on 1–2-celled pedicels, fusiform to short conical, up to 40μ diam. at the widest part; zoösporangia unknown.

Growing on the distal parts of the leaves of *Phyllospadix* sp., Ensenada, Lower California. Collected by N. L. Gardner, No. 4962a, July, 1924. Type, Herb. Univ. Calif., No. 547631.

Ectocarpus ensenadanus is a diminutive species having apparent affinities with *E. irregularis* Kuetz. and *E. simpliciusculus* var. *vitiensis* Askenasy. The type locality of the former is the Adriatic Sea, and of the latter, Vavau Island. It is probably nearest to var. *vitiensis*. In general it has longer cells and shorter conical gametangia than that variety.

Streblonema Desmarestiae sp. nov.

Plate 30, figure 2

Frons totaliter, fructibus exceptis, immersa sed non histologicas aut morphologicas, hostis transformationes producens; filamentis totis monosiphoneis, libere ramosis et in spatiis intercellularibus et per parietes sed non in cavernis cellularum hostis penetrantibus; cellulis multo magnitudine formaque variabilibus; cellulis 6–35 (?) diam., 2–8-plo longioribus; chloroplastis parvis discoideis; gametangiis terminalibus, in pedicellis curtis usque ad superficiem hostis extendentibus, multis, singulis, sparsis, non gregariis aut fasciculatis, sphericis, 12–18μ diam., extra superficiem hostis protrudentibus, loculis parvissimis (2–3μ diam.); zoosporangiis et pilis adhuc non visis.

Fronds not producing conspicuous histological or morphological modifications of the host, wholly endophytic except the fructification organs; filaments monosiphonous throughout, freely branching and penetrating into the intercellular spaces and into the cell walls between the cells but not into the protoplasts; cells very irregular in shape and size, 6–35μ diam., 2–8 times as long as the diameter, with small, discoid, parietal chromatophores; gametangia

terminal on short pedicels extending outward just to the surface of the host, numerous, standing singly, that is, not fasciculate, spherical, 12–18μ diam., with very small (2–3μ diam.) loculi; zoösporangia unknown; hair filaments absent.

Endophytic in the fronds of *Desmarestia munda* S. and G. Kanaka Bay, San Juan Island, Washington, July, 1925. Gardner No. 6086 (Herb. Univ. Calif., No. 510699).

The presence of this species of *Streblonema* was revealed by a slight discoloration of the host in indefinite areas, some smaller and some larger, these areas simply appearing as slightly darker in color. Its presence seems to have no deleterious effect upon the structure of the host, as is sometimes brought about by certain other species of the genus (cf. Setchell and Gardner, Univ. Calif. Publ. Bot., Vol. 8, Pt. 3, p. 440, 1925).

Its affinities with other species of the genus are difficult to determine. The vegetative filaments are relatively large, and the gametangia are relatively small. So far as I am able to ascertain at present, this is the only species in which the gametangia are spherical.

Dictyosiphon sinicola sp. nov.

Plate 31

Frons comparate mollis flaccidaque, 20–30 cm. alta, usque ad 3 mm. diam., aetate provecta cava, moderate et irregulariter ramosa; ramis majoribus axium primarium frequenter et late divaricatis, ceteris in partibus superis strictis, omnibus ramulos curtos, sparsos, attenuatos usque ad ordines tertios quintosque ferentibus, iis in serie unica cellularum terminantibus; cellulis corticalibus in ordinibus longitudinaliter ordinatis, rectangularibus, 10–16μ diam., cellulis medullaribus parietibus tenuibus provisis, longitudine variabilibus sed quam diam. multo-plo longioribus; zoosporangiis subsphaericis in longitudine frondis lente elongatis, 45–60μ diam., parietibus crassis.

Fronds relatively soft and flaccid, 20–30 cm. high, up to 3 mm. diam., hollow in the older parts, moderately and irregularly alternately branched, larger branches of the main axes often widely divaricate, others in the upper parts strict, all giving rise to short, scattered, attenuated ramuli of the third to fifth order, these terminating in a single series of cells; cortical cells arranged somewhat in longitudinal rows, rectangular, 10–16μ diam.; medullary cells thin-walled, 60–80μ diam., variable in length but several diameters long; zoösporangia subspherical, slightly elongated in the longitudinal direction of the frond, 45–60μ diam., thick-walled.

Growing on rocks and muddy bottoms in quiet water. In a small bay at the southern end of San Juan Island, Washington, collected by N. L. Gardner, No. 6075, July, 1925. In Clayoquot Sound, west coast of Vancouver Island, collected by W. A. Setchell and H. E. Parks, July 23, 1930. Type, the former, in the Herb. Univ. Calif., No. 392809.

The type material was distributed from the Herbarium of the University of California, Number 101 of centuries of algae, as *Chordaria dissessa* S. and G. This error was due to a "snap judgment" based upon the extremely close morphological resemblance to that species found growing on the same island; but subsequent microscopical examination of the material revealed the characters which determine its generic position.

Plate 31 represents the upper part of a plant from the type locality. The material from Clayoquot Sound is more robust than the type material. No

complete specimens of the latter were taken, but apparently they may attain a length of 50 centimeters or even more.

Of all the known species of *Dictyosiphon, D. sinicola* seems to be the most robust.

Desmarestia Jordanii sp. nov.

Plate 32

Frons ligulata, atro-fusca, 1 M. et possibile multo-plo longior, minime 7 mm. lata, et axibus primariis fortasse latioribus, ramis 5–6 (?) ordinibus, gradatim angustioribus, ordinibus ramorum omnibus oppositis, aut suboppositis; ramis basim attenuatis; costis angustis sed conspicuis in ramis primariis.

Fronds ligulate, at least a meter and probably several meters long, at least 7 mm. wide and probably the main axes wider, 5–7 (?) orders of branches, each successive order narrower than the preceding one, all orders of branches opposite or subopposite, attenuated at the base, with narrow but fairly conspicuous midrib in the principal branches; dark brown in color.

Cast ashore in the vicinity of Ventura, California. Collected by Frank Jordan and Professor G. R. Johnstone, August, 1933. Type, Herb. Univ. Calif., No. 547730.

Unfortunately the few fragments found cast ashore are all that are at present available for study. From experience with nearly related species, it seems almost certain that these are the primary branches from plants whose primary axes are at least several times longer than these; hence the indefinite statements regarding the size given in the diagnosis.

Its nearest known relative would seem to be *D. herbacea*. It differs from this species, however, in having more orders of branches, all of which are narrower.

Fucus Parksii sp. nov.

Plate 33

Frons flaccida, nitente-fusca, siccitate nigrescens, 10–16 cm. alta, 5–8 mm. lata et equalis sed sub furcam quemque lente cuneata; costa percurrenti sed inconspicua; caecostomatibus cryptostomatibusque fere deuntibus; receptaculis vulgo bifurcatis attenuatisque sed apicibus obtusis, 1.5–2.5 cm. longis; conceptaculis comparate sparsis, sine paraphysibus protrusis.

Fronds flaccid, mostly 10–16 cm. high and 5–8 mm. wide, maintaining approximately the same width throughout but slightly wider below each forking, making the segments between forkings slightly cuneate; midrib percurrent but inconspicuous; practically free from both caecostomata and cryptostomata; color glossy brown, turning dark on drying; receptacles mostly bifurcate, usually attenuated but with blunt apices, 1.5–2.5 cm. long; conceptacles relatively sparse, without protruding paraphyses.

Attached to wood, stones, etc., in the upper littoral belt. Humboldt Bay, California. Abundant at Eureka. Collected by H. E. Parks, No. 4573, July, 1934. Type, Herb. Univ. Calif., No. 547633.

The locality named above is the only one known in which this species of *Fucus* grows. It has a close resemblance to *Fucus evanescens* f. *oregonensis* Gardner, but differs from this species in being more profusely branched as a rule, in having smaller and more acute receptacles, and in the absence of cryptostomata. In *F. Parksii* there are no caecostomata, and one has to search

diligently to locate a single small cryptostomata. In the absence of these modifications in the fronds, this species resembles certain forms of ***Fucus edentatus***. In other respects it is unlike any known form of that species.

Search has been made for *F. Parksii* at the mouth of and outside of Humboldt Bay, in the open ocean, but no specimens have yet been located.

Pelvetiopsis arborescens sp. nov.

Plate 34

Frons comparate robusta, olivaceo-viridis ad flavescens, usque e basi discoideo comparate lato dichotoma usque ad subdichotoma, 5–15 cm. alta, inferne cylindrica, superne gradatim angustior et complanata; receptaculis numerosissimis, subcylindricis, obtusis, 5–8 mm. longis; conceptaculis numerosissimis.

Fronds relatively robust, dichotomously to subdichotomously branched beginning almost at the relatively large discoid base, 5–15 cm. high, cylindrical below, becoming very gradually narrower and complanate above; receptacles very numerous, subcylindrical, blunt, 5–8 mm. long; conceptacles very numerous; color olive green to yellowish.

Growing on rocks in the middle and lower litoral belt, exposed to heavy surf. Point Carmel (Point Lobos), Monterey County, California. Collected in July, 1918, by N. L. Gardner, and in the same locality by Fred M. Reed, No. 3, August 23, 1934. Type, Gardner, No. 4301 (Herb. Univ. Calif., No. 543949).

This species of *Pelvetiopsis* is very closely related to *P. limitata* f. *typica* and *P. limitata* f. *lata,* but differs from both in being more profusely branched, in having its frond cylindrical below and somewhat compressed above instead of being decidedly complanate throughout and usually canaliculate below as the two above-mentioned forms are, and in having smaller, blunt, subcylindrical receptacles. It also grows lower down in the littoral belt than either of the other two forms.

Dictyopteris Johnstonei sp. nov.

Plate 35

Frons 7 cm. et ultra alta, 1–2 mm. lata, dichotomo-flabellata, atro-fusca, costa inconspicua; ramis et axibus primariis prorsus linearibus, ramulis ultimis quam latis quam iis inferioribus, angulis moderatis emergentibus, superne plus plusque numerosioribus; marginibus levibus, cellulis superficientium in ordinibus stricte longitudinalibus, quibusquibusque ad marginem arcuatis, chloroplastis arcte aggregatis impletis; sectione transversali margine uni usque ad 10 stratoso et ultra in medio; aplanosporangiis sparsissimis in superficie ramulorum ultimorum singulis, usque ad 100μ diam. oogoniis in gregibus parvis (15–30), aggregatis, in utraque superficie promiscue sparsis; antheridiis adhuc non visis; pilis in gregibus parvis raris; partibus laesis filamenta magna, monosiphonea, numerosa emittentibus.

Fronds 7 or more cm. high, 1–2 mm. wide, dichotomo-flabellately branched, with an inconspicuous midrib; branches and main rhachis linear throughout, the ultimate ramuli as wide as or wider than the lower parts, arising at moderately wide angles, forking with increasing frequency in the upper part of the frond; margins smooth; color dark brown; surface layer of cells arranged in very definite longitudinal rows curving outward to the margins, crowded with discoid chromatophores; thickness of frond varying from a single row of marginal cells to 10 or possibly more layers in the thickest part; aplanosporangia very sparse, promiscuously scattered on one side of the upper ramuli, single, up to 100μ

diam.; oögonia in small groups, 15–30, promiscuously scattered on both sides of the ramuli; antheridia unknown; an occasional small group of hairs present; injured parts giving rise to numerous relatively large monosiphonous rhizoidal filaments.

Dredged from twenty-five fathoms depth at Lone Cove, southern California, November 28, 1928. Type, G. R. Johnstone, No. 96 (Herb. Univ. Calif., No. 472507).

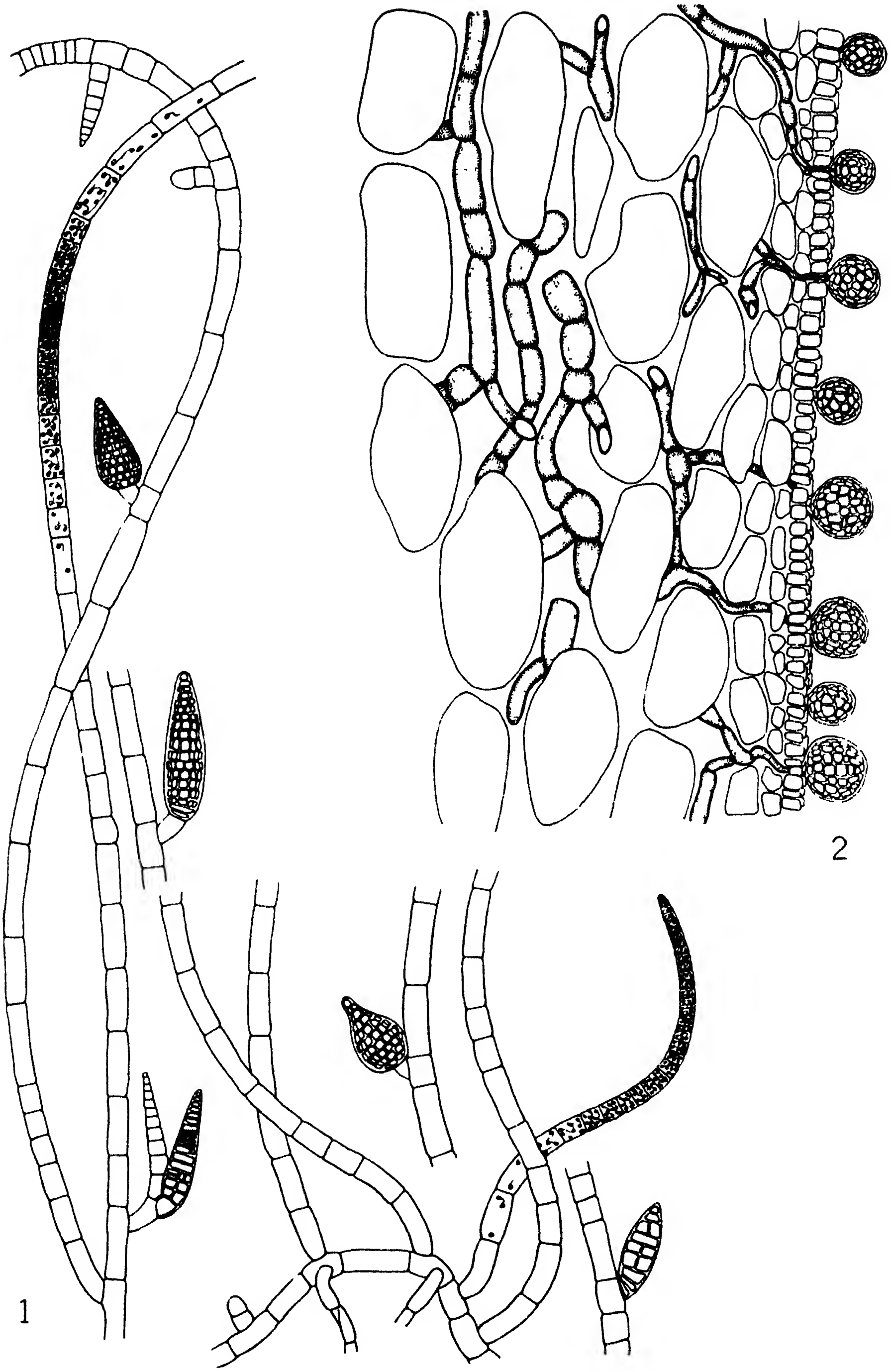
The material upon which the species is based consists of a single, apparently fragmentary, part of a plant, there being no base present. It may be that the species is many times larger than the specimen represented on plate 35 and that it has a stupose basal part characteristic at least of most species of the genus.

EXPLANATION OF PLATES

PLATE 30

Fig. 1. *Ectocarpus ensenadanus* sp. nov. Portions of filaments, showing short cells of the meristem and various shapes of gametangia. × 150.

Fig. 2. *Streblonema Desmarestiae* sp. nov. Showing vegetative filaments within the host and spherical gametangia on the surface of the host. × 500.



1

2

PLATE 31

Dictyosiphon saxicola sp. nov.

Photograph of the type specimen.


MILLIMETER.

PLATE 32

Desmarestia Jordanii sp. nov.

Photograph of the type specimen


MILLIMETER

PLATE 33

Fucus Parksii sp. nov.

Photograph of the type specimen.

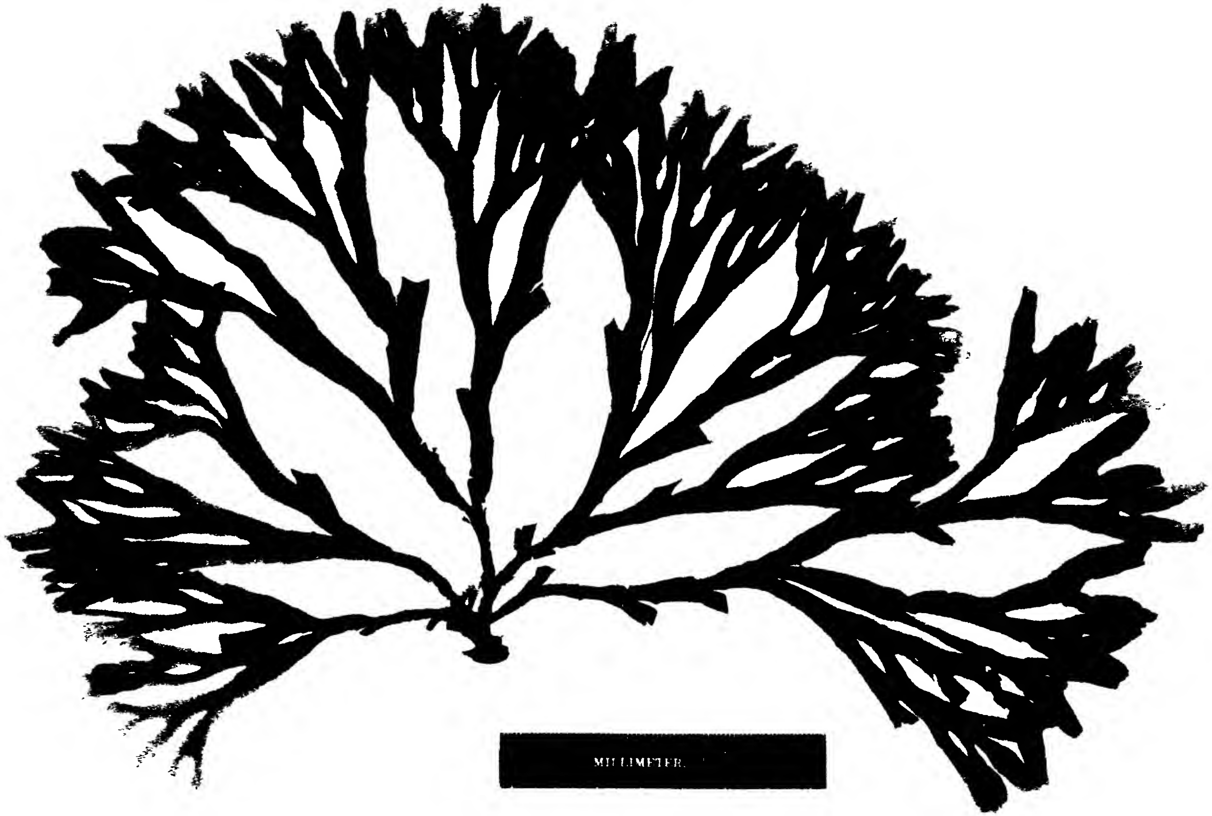

MILLIMETER.

PLATE 34

Pelvetiopsis arborescens sp. nov.

Photograph of the type specimen.


MILLIMETER.

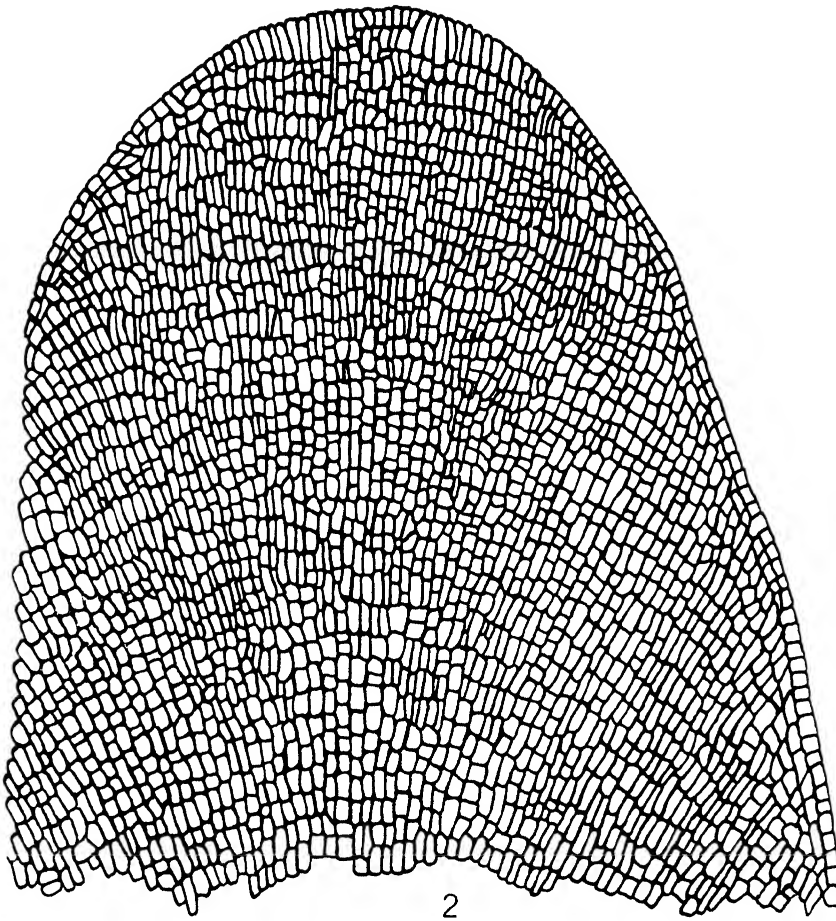
PLATE 35

Dictyopteris Johnstonei sp. nov.

Fig. 1. A photograph of the type, natural size.

Fig. 2. Apex of a branch. × 125.

Fig. 3. Cross section of a typical branch. × 125.



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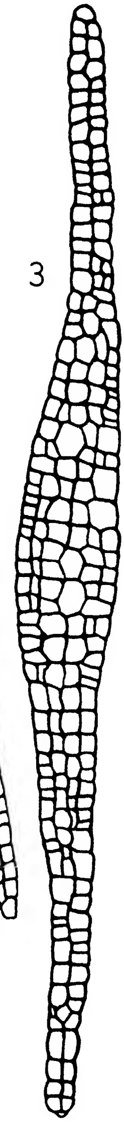

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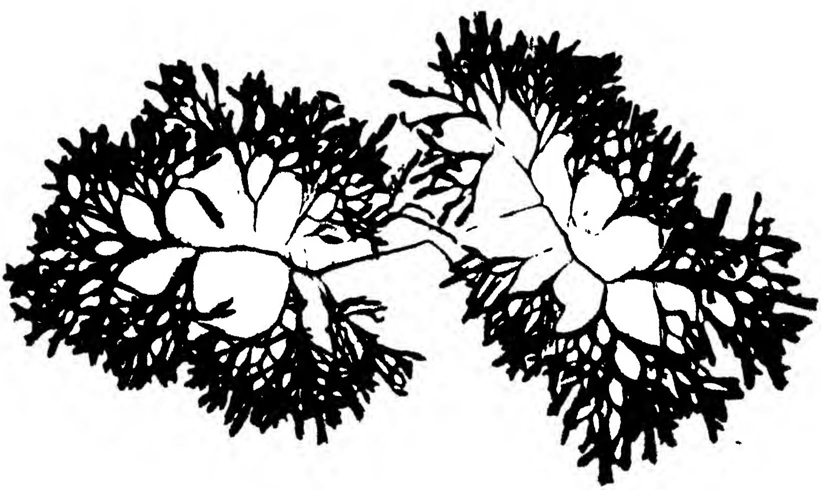

1

TROPICAL AMERICAN FERNS

BY

EDWIN BINGHAM COPELAND

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TROPICAL AMERICAN FERNS

BY

EDWIN BINGHAM COPELAND

Athyrium Skinneri Moore (*nomen*): Baker, as *Asplenium*

Plate 36

Rhizomate repente, 2–3 mm. crasso, apice paleis stramineis ovatis 2 mm. longis vestito; stipitibus haud remotis, 8–12 cm. altis, carnosis, ca. 3 mm. crassis, pallide viridibus, sparse et inconspicue paleatis; fronde 10 cm. longa, ovata, acuminata, basi truncata, bipinnatifida sursum pinnatifida, herbacea flaccida, glabra, rhachi anguste alata; pinnis ca. 4-paribus, suboppositis, infimis breviter pedicellatis usque ad 5 cm. longis, 2–2.5 cm. latis, subfalcatis, acuminatis, basi obliquis, ½–⅔ versus costam pinnatifidis, segmentis contiguis oblongis obtusis inciso-serratis infimo acroscopico maximo; venis angulo acuto salientibus, simplicibus; soris medialibus, indusio griseo glabro, plerumque more Athyrii curvato vel obliquo, interdum symmetrice nephrodiiforme, rarius recto asplenioideo.

Guerrero: Sierra Madre del Sur, Barranca de la Guacamayo, alt. 495 m., Mexia No. 8859, "Hab. Trickles on shady cliff."

A relative of *Athyrium achilleaefolium* (Mart. & Gal.) Fée, and with apparent affinity to *Dryopteris mexicana* (Presl) C. Chr. and *D. cinnamomea* (Cav.) C. Chr., distinguished by its stout, fleshy stipe and less deeply cut pinnae. The paleae are about 2 mm. long, ovate on the rhizome, narrower on the stipe, their length less than the diameter of the stipe. The sori of *D. cinnamomea* are known to be inconstant in form, but not in any such degree as are those of *A. Skinneri.*

Dryopteris blanda (Fée) C. Chr. Cf. Monog. Dryopteris, I:133.

Vera Cruz: Atoyac River, alt. 600 m., on earth bank in shade, Copeland Mex. Ferns No. 32; also, on limestone above Songsong River, alt. 900 m.

My specimens are well developed and by description would seem to be a distinct species; those first distributed were named as new. However, comparison with the series of collections in the United States National Herbarium convinces me that the species, as *Phegopteris blanda* and as *P. caespitosa,* was based on ill-developed plants, and that the description should be made to apply to fronds more than 25 cm. long and 12 cm. wide. The National Herbarium specimens are: Bourgeau No. 2005; Fink No. 96 a, these both from Cordova, as in effect are my plants; Purpus No. 5947, from Misantla; Barber No. 171, from Guatemala; and Blake No. 7361, from Honduras. The Purpus collection is most like mine. Large specimens have crenate-serrate segments, and the most ample segments sometimes have most of the veinlets forked. The sori may then be below the fork, or at the fork, or just above it and paired. Setae on the costae of the pinnae are sometimes paired. The large deflexed lowest pinnae, narrowed at the base, are the most conspicuous feature of the species in full development.

Dryopteris polyphylla Copel., sp. nov.

Plate 37

Rhizomate breve adscendente; stipitibus caespitosis permultis, basi ima paleis castaneis parvis integris nudis lanceolatis vestitis, deinde sparse squamulosis et laminam versus rhachibusque puberulis epaleatis; fronde usque ad 12 cm. longa et 4 cm. lata, acuminata, bipinnatifida, herbacea; pinnis suboppositis, medialibus breviter (1 mm.) stipitulatis horizontalibus, basi suboblique truncatis, 5–7 mm. latis, apice obtusis, medio ad costam oblique pinnatifido-lobatis, costis sparse setuliferis, segmentis oblongis vel latioribus inconspicue ciliatis; pinnis infimis vix abbreviatis, leviter deflexis, segmento infimo basiscopico reducto; venulis simplicibus, ca. 3-paribus, nudis; soris inframedialibus, globosis, nudis.

Vera Cruz: below Sumidero, alt. 1000 m., on sheltered sheer limestone, mixed with *D. reptans*, Copeland Mex. Ferns No. 33.

This conforms better than does the preceding species, as represented by my No. 32, with the published descriptions of *D. blanda,* and I so determined it before receiving authentic speeimens from Dr. Maxon. It is just possible that it is an extreme edaphic form of *D. blanda;* but it seems to be distinguishable by short-stalked and less divided pinnae, broader segments, and marginal setae. In all forms which I construe as *D. blanda,* the pinnae are sessile.

Blechnum ensiforme (Liebm.) C. Chr.

Oaxaca: Dist. Choapam, Santa María, alt. 1500 m., Mexia No. 9280, "climbing tree trunks in dense virgin forest." Collected also in Chiapas, Purpus No. 6741.

This species seems to be little known, but the identification is clear. The type source is given as "Teotalcingo, Dep. Oaxaca District Chinautla (4–5000′)," not far from Mrs. Mexia's locality. Liebmann does not mention the rhizome, and it is not shown by Purpus' specimens; but the scandent growth is the most striking feature of the species. It is the rhizome which is scandent, which of course shows no near affinity to *Salpichlaena* (or *Blechnum*) *volubilis,* with scandent rachis.

Blechnum subdimorphum Copel., sp. nov.

Plate 38

Caudice breve erecta stolonifera, paleis ovatis integris brunneis linea mediale indistincta castanea vestita; stipitibus dense fasciculatis, frondis sterilis 2–6 cm. longis stramineis deorsum paleis ovatis sursum anguste lanceolatis et sparsis vestitis; frondibus pinnatis pinnis 2–4-paribus, sterilibus infimis sessilibus basi late rotundatis, cunctis adnatis, vulgo 4 cm. longis 7 mm. latis, acutis, rectis vel subfalcatis, terminale majore usque ad 6 cm. longa et 12 mm. lata; fronde fertile longe (8–15 cm.) stipitata, pinnis longioribus et angustioribus acuminatis infimis brevipedicellatis sequentibus sessilibus supremis adnatis, soris fere ad basin et apicem protensis.

Vera Cruz: Cordova, secus vias, alt. 800 m., Jan. 31, 1938, Copeland Mex. Ferns No. 50; also, Tuzpango (Orizaba), alt. 1000 m.

This species is long known, but apparently never described nor given a distinctive name. It is fairly surely the *B. intermedium* of Liebmann, Mex. Bregner, p. 86, collected near Mirador (Huatusco); but, as Liebmann observed, it

fits ill the description and figure of Kunze, Farrnkr., p. 128, pl. 57, f. 2, which must be authentic, since Link described the species from specimens cultivated in the same garden. Purpus 2376 and 2376′, likewise from Huatusco (Zacuapam), were distributed as *B. longifolium* HBK.; the name is untenable, and these are clearly not *B. fraxineum.*

Asplenium subvestitum Copel., sp. nov.

Plate 39

Rhizomate erecto vel adscendente, apice basibusque stipitum paleis atris ovatis acuminatis margine interdum piliferis vestitis; stipitibus sordide fuscis sursum paleis caducis sparsis minoribus brunneis aspersis; fronde 20–30 cm. longa, late lanceolata, acuminata, tripinnatifida, rhachi fibrillis castaneis minutis dissectis vestita: pinnis subsessilibus late lanceolatis, rhachibus anguste alatis inferne deorsum sparse fibrilliferis; pinnulis late trapezoideis majoribus profunde incisis lobis inferioribus furcatis, segmentis resp. dentibus brevimucronatis, membranaceis, glabris; soris prope basibus pinnularum, brevibus, indusiis latis, pallidis.

Guerrero: Dist. Mona, Sierra Madre del Sur, west of Petlacala, alt. 1900 m., Mexia No. 9065, in shady stream bed.

Nearest to *A. commutatum* Mett., from which it is distinguished by black instead of brown basal paleae, glabrescent stipe, fibrillae rather than laciniate paleae on the rachis, rather more dissected frond, and fewer but larger sori. *A. myapteron* Fée is described as "très-glabre," and distinct in some other respects, but we have *A. commutatum* from near both of the localities from which it was described.

Asplenium pinnatum Copel., sp. nov.

Plate 40

Rhizomate adscendente, 5 mm. crasso, paleis castaneis lanceolatis attenuatis vestito; stipitibus fasciculatis, 30 cm. altis, atropurpureis, nitidis; fronde vix aequilonga, 5–7 cm. lata, imparipinnata, pinna apicale triloba‹a; pinnis 5–8-paribus, oppositis, sessilibus, usque ad 4 cm. longis et 2 cm. latis, basi latissime et subsymmetrice cuneatis, plerisque acutis rarius acuminatis et basalibus interdum rotundatis, integris vel subintegris, coriaceis, glabris, viridibus, costa venisque immersis; soris pinnularum majorum ca. 5–paribus, longe imbricatis, impressis et interdum e facie superiore praestantibus, indusio angusto, pallido.

Guerrero: Dist. Mina, Sierra Madre del Sur, Petlacala, west of Reyes, alt. 1800 m., Mexia No. 9048, on shady stream bank.

One of the group of *A. integerrimum,* but very distinct, in aspect suggestive only of the Oriental *A. zamioides,* more like *Adiantum macrophyllum* than like any *Asplenium.*

Pteris inflexa Copel., sp. nov.

Plate 41

Rhizomate brevi-repente, crassissimo, et pilis et paleis angustis in pila transeuntibus vestito; stipitibus confertis, usque ad 2 m. altis, basi 3 cm. crassis, castaneis, sursum fulvis vel stramineseentibus glabrescentibus nitidis; fronde 1–1.5 m. longa et lata, tripartita pinnis basalibus bis furcatis, parte mediale bipinnatifida, pinnis supremis sessilibus infe-

rioribus plerisque pedicellatis stipitulis 1–3 mm. longis, medialibus usque ad 17 cm. longis, 3 cm. latis, ad alam utroque latere costae 2–4 mm. latam pinnatifidis, caudatis cauda ad apicem integra deorsum argute serrulata sterile, herbaceis, costa venis et lamina utraque facie more Pt. laciniatae sed sparsius pubescentibus; segmentis 8–12 mm. longis, 4 mm. latis, falcato-inflexis, mucronatis, supra soros argute serrulatis, sinubus latis rotundatis; soris ultra mediam longitudinem segmentorum adscendentibus, circum sinus continuis vel rarius ibidem interruptis, indusiis angustis; venis areolas lineares secus costas et series 1–2 latarum et irregularium includentibus.

Vera Cruz: near Orizaba, in the deep gorge of an affluent of the Songsong River, alt. 1200 m., Copeland Mex. Ferns No. 79; only two plants found.

This is the largest of the large local species of *Pteris*. It is a relative of *P. podophylla* Sw. and of *P. laciniata* Willd. *P. laciniata* and *P. Orizabae* occur at no great distance, and this might conceivably be a hybrid, less pubescent than the former and with reticulate venation, with much broader sinuses than either.

I construe *P. Orizabae* M. & G. by Dr. Maxon's identification of No. 78 of my Mexican distribution; our several older specimens of the same fern were partly so named, partly labeled *P. podophylla*. It is tripartite, which does not appear from the original description; but complaint that Galeotti collected too fragmentary specimens goes back as far as Liebmann. *P. Orizabae, P. apicalis* Liebm., and *P. pulchra* S. & C. are all described as glabrous or essentially so, like *P. podophylla,* whereas the pubescence of *P. inflexa* is conspicuous. The last is also of much thinner texture.

In spite of the current opinion (Trevisan, Kuhn, Underwood, Christensen, Maxon), I construe *Lonchitis hirsuta* L. as the type of its genus. This is not because it was the first listed, but because Linnaeus explicitly knew his *Lonchitis* as a living plant—see the asterisk on the name in Genera Plantarum; and it seems repugnant to common sense to typify his genus by the picture of an unseen plant when he knew it by a living specimen. I can find no record of the cultivation of *L. aurita,* and Hooker, Sp. Fil., II: 56, says that "it appears to be unknown to any author since the time of Plumier"—sufficient evidence that it was not in culture where Linnaeus could have seen it. I do not know when *L. hirsuta* came into culture, but Schkuhr figured the details of his illustration from fresh material, and Kunze says that the Berlin Garden received living material from Kew in 1793. *L. hirsuta* being the type of *Lonchitis* because it is the species Linnaeus must have known personally, *Anisosorus* Trevisan joins *Antiosorus* Roemer: Kuhn as a synonym.

Those who would place *L. hirsuta* and *L. aurita* in different genera may provide a new generic name for the latter; the necessity is not evident to me.

And I go farther in failure to see generic differences. Contrary to the judgment of Trevisan, Kuhn, Underwood, Maxon, and Christensen, but in agreement with Willdenow, Hooker, J. Smith, and Christ, I believe that *L. hirsuta* is too intimately related to *Pteris* to demand separation on the basis of genealogy, and that it is without distinctive characters which might make its separation convenient. Moreover, I believe that *Lonchitis* of Linnaeus, excluding *L. repens* which is *Hypolepis,* but not *L. pedata* (*P. podophylla*), is a

really natural group—which is my reason for not wanting a new name for *L. aurita,* apparently provided with a name in *Pteris* as *P. lindeniana* (Hooker) Christ. Most post-Linnaean species, including all in my hands, are also already named in *Pteris.*

As a *Pteris, P. laciniata* belongs in the group with areolate venation, though its veins are free.

The distinction between hairy and scaly ferns may be absolute, as the rhizomes of *Polypodium* and *Davallia* bear scales, even if they may be contracted into bristles; or it may be less sharp but still useful; or it may break down, as in the *Sphenomeris-Tapeinidium-Lindsaya* series there is no sharp line between hairs and scales, the scales being variably widened hairs, quite distinct from the peltate paleae of the Oleandrid ferns. The last is the condition in the group under discussion. *P. laciniata* is chaetopterid, with hairy rather than scaly rhizome; but widened hairs, several cells wide, occur mixed with filaments of cells (typical hairs) on the rhizome and on the base of the stipe. *P. inflexa* has broader and larger paleae, mixed with hairs, on these parts, but the pubescence of the frond is like that of *P. laciniata,* only somewhat less dense. A plant with pubescence of the same general type is ascribed to *P. podophylla* as var. *infrapubescens* Hieron. The affinity of all of these plants is too manifest for question.

To summarize: I believe that *Lonchitis* should be merged in *Pteris.* However, if everything in the preceding paragraphs be valid, there is another possible conclusion—that a part of *Pteris* should be transferred to *Lonchitis.* This would be a part of Presl's genus *Litobrochia.* As a matter of definition (convenience) *Lonchitis* would then present difficulties, and so would *Pteris.* A transfer in this direction can therefore be justified only by evidence, which I do not now detect, that the resulting groups would be clear phyletic entities.

Polypodium sursumcurrens Copel., sp. nov.

Plate 42

Rhizomate 5 mm. crasso, breve, paleis ovatis acutis integris fuscis nigrescentibus vestito, superne cicatricibus stipitum magnis ornato; stipitibus fere contiguis usque ad 12 cm. altis 2 mm. crassis, basi atropurpureis pilis 1 mm. longis castaneis dense velutinis, sursum fuscis sparsius pubescentibus angustissime viridi-alatis; fronde 20–30 cm. longa, 5–6 cm. lata, utrinque angustata, basi pinnata alibi vix ad costam pinnatisecta, elastica, costa utraque facie denso minute fusco-pubescente, haud squamulosa; pinnis et segmentis infimis reductis deflexis, medialibus recte patentibus, rectis, 3 cm. longis 4 mm. latis, obtusis vel subacutis, crenulatis, basi obliquis basiscopice vix dilatitis acrosopice secus costam usque ad sequentes dilatatis, papyraceis (siccis), inferne minute puberulis superne glabrescentibus; venis furcatis; soris submarginalibus impressis, facie superiore sat conspicuis.

Vera Cruz: mountaintops at head of Orizaba Valley, alt. 2400 m., epiphytic in mossy woods, Jan. 13, 1938, Copeland Mex. Ferns No. 128.

This species is locally abundant along the Tehuacan-Orizaba highway immediately below the pass. The formation, mossy oak woods, has been a favorite of all collectors, and the locality, although not quite on the old road between Puebla and Orizaba, may well have been visited; still, I cannot identify this

with any of the several described Mexican species of the group. It is notable for the crenulate segments with very oblique bases, the short, dark pubescence, and the almost marginal sori.

Polypodium cyathicolum Copel., sp. nov.

Plate 43

Rhizomate 2–4 mm. crasso, breve, paleis ovatis acutis integris fusco-ferrugineis 2–3 mm. longis vestito cicatricibusque magnis fere contiguis stipitum ornato; stipite 5 cm. alto, atrocastaneo vel nigro, pube brevissima primo densa vestito; fronde ca. 30 cm. longa 5 cm. lata, utrinque angustata, elastica et plerumque arcuata, basi imo pinnata alibi vix ad costam pectinata, pinnis et segmentis infimis conspicue deflexis, medialibus horizontalibus acutis 3–4 mm. latis apud costam fere duplo latioribus integris papyraceis sparse et minute puberulis et ciliatis, costis nigris, venis occultis furcatis; costa nigra, pilis minutis albidis obsita; soris parvis, medialibus vel margini propioribus.

Vera Cruz: Cuautlancillo, 10 km. north of Orizaba, alt. 1600 m., on trunk of *Cyathea* in damp ravine, Copeland Mex. Ferns No. 127; seen but once.

Similar in appearance to *P. Plumula,* but with minutely pubescent, non-scaly rachis. Conspicuous peculiarities are the many large scars of fallen stipes, and the strongly deflexed basal pinnae and segments.

Polypodium Villagranii Copel., sp. nov.

Plate 44

Rhizomate repente, 2 mm. crasso, paleis stramineis lanceolatis 6 mm. longis subintegris imbricatis vestito; stipitibus inter se 1–2 cm. distantibus, 2–5 cm. longis, paleis brevioribus squarrosis albidis et lanceolatis et ovatis attenuatis basi peltatis margine deorsum inconspicue setuliferis vestitis; fronde ca. 15 cm. longa, 3 cm. lata, basi truncata, vix ad rhachin pectinata, rhachi inferne nigra paleis lanceolatis et ovatis ca. 2 mm. longis apice protensis alibi spinulifero-ciliatis, superne paleis 2–3 mm. longis acicularibus basi parva orbiculari-peltatis vestita; segmentis coriaceis, ca. 3 mm. latis, obtusis, integris, superne paleis albis acicularibus 2 mm. longis basi peltatis erosis sparsis, inferne paleis fulvis albescentibus lanceolatis densissime imbricatis vestitis; venis furcatis, liberis; soris medialibus, denique inter paleas manifestis.

Hidalgo: Santa Ana, alt. 1200 m., on mossy tree, Copeland Mex. Ferns No. 143.

A relative of *P. furfuraceum,* but very distinct in paleae. It bears the name of Professor F. P. Villagran, of the National University of Mexico.

Polypodium colysoides Maxon & Copeland, sp. nov.

Plate 45

Rhizomate repente, 2 mm. crasso, paleis et lanceolatis 2–3 mm. longis et ovatis brevioribus appressis castaneis vestitis; stipitibus gracilibus, basi sparse squamulifera excepta angustissime viridi-bialatis, frondium sterilium 10 cm. fertilium 20 cm. longis; fronde fertile 10–15 cm. longa, ovata, basi pinnata alibi pinnatisecta, pinnis et segmentis plerumque triparibus lanceolatis 1–1.5 cm. latis utrinque angustatis sed basi ima adnato-dilatatis integris vel hinc inde obscure sinuatis herbaceis squamulis minutis peltatis plerisque orbicularibus rarius ovatis vel lanceolatis inconspicue vestitis superne subglabrescentibus, rhachi anguste alata sparse squamulifera; fronde sterile aut pinnata pinnis saepius uniparibus aut hastata aut simplice et integra lanceolata 2–3 cm. lata; venis anastomosantibus,

plerumque more Goniophlebii, marginem versus liberis; soris linearibus, 3–6 mm. longis, oblique positis.

Vera Cruz: Atoyac River, alt. 600 m., on limestone and tree trunks beside river, common at the great spring where the river emerges ("Ojo de Agua"), and rare down the stream, Copeland Mex. Ferns No. 135, type; also Hugo Fink 45, "County of Cordova," not improbably from the same spot.

The gross resemblance of this fern to *Colysis* is so striking that in collecting it I felt sure that I had another example, like *Plagiogyria, Loxogramme,* and *Coniogramme,* of a fern which had jumped over the Pacific Ocean. However, the resemblance is wholly superficial, as shown by the almost complete absence of recurrent veinlets, the presence of peltate scales on the lamina, and otherwise. Very surely, though, it is related to *P. rhachipterygium* Liebmann, which is scaleless, a much larger fern with many large pinnae, regularly goniophlebioid venation, conspicuously winged rachis, and shorter sori. This was described from Chinantla, farther south in the state of Oaxaca, and has since been redescribed as *P. Donnell-Smithii* Christ, from Guatemala, and reported by Christ, *ibid.,* from Tabasco. Another relative is *P. Bradeorum* Ros., of Costa Rica, known with simple fronds only, very similar to *P. colysoides* in scales, similar in venation except as the broader lamina complicates the reticulation, with longer sori and firmer texture. Also in the same group is a Nicaragua fern, Schramm No. 22, firmer and less scaly than *P. colysoides,* not to be named because the specimen in hand, U. S. Nat. Herb. No. 1266161, is sterile.

As to the affinity of the group: With only *P. rhachipterygium* to consider, Liebmann, Mex. Bregner 39, placed it in *Marginaria,* defining that subgenus by the venation and including with diverse components the American ferns more commonly called *Goniophlebium.* The latter group seems nearer to *Eu-Polypodium* than to the Oriental *Goniophlebium* of Blume; it may represent the real affinity of *P. colysoides.* But affinity to *Pleopeltis* seems to me at least as likely. And hybridization across group boundaries, making the phylogeny of these ferns a network instead of a freely branching system, may have to be invoked to explain the presence of peltate scales on a part of them, as well as the irregularity of the venation. (Diagnosis and discussion by E. B. C. Dr. Maxon has long recognized Fink's collection as new, had noted the resemblance to *P. ellipticum* Thunb., and contributed the annotated material from the National Herbarium.)

Polypodium pleolepis Maxon & Copeland, sp. nov.

Plate 46

Rhizomate repente, 3 mm. crasso, paleis ferrugineo-castaneis 3 mm. longis lanceolatis margine pallidis erosis dense vestito; stipitibus frondium sterilium 10 cm. fertilium 20 cm. longis, ubique paleis ferrugineis 2–4 mm. longis lanceolatis acuminatis ornatis, sursum lamina decurrente angustissime alatis; fronde fertile vix 10 cm. longa, late ovata, pinnata, rhachi sursum conspicue alata; pinnis 2–4-paribus, lanceolatis, utrinque angustatis, basi adnatis et plus minus dilatatis, integris, subcoriaceis, inferne paleis peltatis et orbicularibus eroso-fimbriatis et elongatis vestitis superne tum demum glabrescentibus; fronde sterile aut pinnata aut pinnatisecta, pinnis 1–3-paribus latioribus, venis more Goniophlebii anastomosantibus sed extra seriem areolarum magnarum plerumque aliam minorum irregula-

rium sine venulis inclusis efficientibus, marginem versus liberis; soris oblongis, oblique positis, ca. 2 mm. longis.

Guatemala: Barranca del Rubelcruz, alt. 3000 feet, von Tuerckheim: Donnell-Smith No. 673, type in U. S. Nat. Herb., No. 833677, August, 1885. A duplicate sheet, No. 50578, seems to bear specimens collected by von Tuerckheim in 1887 and by Donnell-Smith in 1890. Sheet No. 833678, Donnell-Smith No. 1557, from the same barranca, alt. 2500 feet, collected in 1889, is the same species, but more scaly and less dimorphous. All were distributed as *P. angustum* Mett., but the type bears also a printed label "*P. trilobo Cav. proximum.*"

Nearly related to *P. colysoides,* from which it differs most conspicuously in being more scaly and of firmer texture.

Bolbitis cladorrhizans (Spr.) Ching.

Acrostichum irregulare Liebm., Mex. Bregner (1849), p. 21.

Vera Cruz: 30 km. below Cordova, alt. 400 m., in ravine, 1. D. M. Forbes.

The agreement with Liebmann's description is close enough to leave no doubt of the identity. His type locality is Barranca de Santa María Tlatotla, near Fortín, alt. 1500–1800 feet. This is not the Fortín which is now a center of flower culture above Cordova. The name means "little fort," and was applied to any place where a guard or watch might have some protection. Liebmann's plant is described as most inconstant in form of frond, and there is no evident distinction from *B. cladorrhizans* except the negative one that there is no mention of a rooting apex. Less than one frond in ten of Mr. Forbes's collection is radicant.

Lycopodium Mexiae Copel., sp. nov.

Plate 47

Terrestre, gregis L. reflexi Lam., ramis erectis, 20 cm. altis, plerumque semel furcatis rarius aut simplicibus aut bis dichotomis, foliis exclusis 2–3 mm. foliis inclusis ca. 16 mm. diametro; foliis uniformibus linearibus 0.5 mm. latis, 5–7 mm. longis, caudicem fere tegentibus, squarrosis, modo reflexis, margine minutissime hyalino-spinuliferis, costis praecipue inferne manifestis, foliis superioribus omnibus sporangiferis.

Peru: Huánuco, Dist. Churubamba, Hacienda Mercedes, on bank in cleared land, alt. 1875 m., Mexia No. 8193 a.

Stouter than *L. reflexum,* and the leaves less reflexed; but it may be Baker's var. *densifolium,* Fern Allies, p. 11.

Mecodium Mexiae Copel., sp. nov.

Plate 48

Rhizomate late scandente filiforme setis sparsis castaneis vestito; stipite 4–10 mm. longo, rhachique ubique anguste alatis; fronde 5–8 cm. alta lanceolato-ovata, subacuta, tripinnatifida, glabra, membranacea, viride; pinnis infimis plerumque brevibus et deflexis, medialibus sessilibus oblique ovatis obtusis, segmentis 1 mm. latis integris emarginatis; cellulis mediocribus, hexagonis, parietibus tenuibus; soris ad partem superiorem frondis restrictis, ibidem in apices segmentorum fere omnium insertis, vix 1 mm. latis basi leviter immersis, valvis rarius ovatis obtusis, saepius depresso-orbicularibus quam longis latioribus integris, receptaculo parvo incluso.

Peru: Huánuco, near junction of Cayumba and Huallaga rivers, on tree trunk in dense forest, alt. 87 m., Mexia No. 8282, Oct. 12, 1936.

Recognizable by its very short stipe, winged to the base. The rachis is slightly elastic, tending to curve backward in drying, but the pinnae and segments remain plane, and are hardly imbricate.

Sphaerocionium crispum (H. B. K.) Kl.

This was omitted in the list of the species of this genus in my Genera Hymenophyllacearum in consequence of confusion with *S. ciliatum*. They belong in the same section, but resemblance ends there.

Hymenophyllum peruvianum H. & G.

Bolivia: Prov. Sur Yungas, loc. Colaya, alt. 1785 m., on tree trunk in virgin forest, Mexia No. 7820.

The dried fronds are deep green, the oldest ones very dark, but none at all brown. As in all relatives, the sori are mostly or wholly in the upper part of the fronds. The larger fronds have the larger segments 2- or 3-furcate. The only notable discrepancy from the original description is in color. It is nearer to *H. fucoides* Sw. than some of the species given that name in Synopsis Filicum, but is still very distinct.

Buesia megistocarpa Copel., sp. nov.

Stipite gracillimo, obscuro, nudo; fronde ca. 15 cm. longa, 3 cm. lata, acuminata, pendente, olivaceo-viride, bipinnatifida, pinnis infimis paullo remotis et minoribus, rhachi ibidem nuda, alibi et alata et dentibus vel pilis 2 mm. longis 1–4 cellulis in latetudine basi interdum longitudinaliter dilatatis ornata; pinnis medialibus 2 cm. longis, 10 mm. latis, obtusis; segmentis adscendentibus, contiguis, usque ad 1 cm. latis, spinoso-serratis, costis inferne pilis usque ad 2 mm. longis, 1–3 cellulis in latitudine ornatis, lamina utroque latere costae 1 mm. lata, cellularum parietibus rectis tenuibus, interaneis ad parietes anguste appressis; soris in axillis pinnarum pedicellatis, pedicellis nigris exalatis 1 mm. longis, apud basin involucri pila ferruginea conferta 2 mm. vel ultra longa emittentibus, involucro 4–5 mm. longo, 2–3 mm. lato, nigro, fere ad basin fisso, apice late rotundato, sicco plicato, hinc inde inter pila fisso, margine praecipue ad apicem pulcherrime ciliato pilis vulgo 1 mm. longis, receptaculo crasso clavato incluso.

Ecuador: Carchi, trail from Moran to Olivos, alt. 3200 m., on tree trunk in dense forest, Mexia No. 7458b, July 10, 1935.

This differs from *B. mirifica* and *B. Sodiroi* by its compact fronds and broad segments, and has involucres even larger than those of *B. Sodiroi*, relatively long, and remarkably long ciliate. *B. Jamesoni* is known to me only by Hooker's description and figure, Spec. Filicum, I: 96, pl. 35A; it seems to be more lax and more slender, with smaller and rounder, sessile involucres and different margins.

Mrs. Mexia collected at the same time specimens which I identify with *B. Sodiroi*, though they are no more than 10 cm. in length of frond.

Both *B. Sodiroi* and *B. megistocarpa* have the receptacle elongate, as in *Hymenophyllum* (but included), instead of globose, as Morton found those

of *B. mirifica*. Although this breaks down what was regarded as a diagnostic character of the genus, the genus still seems to me to be a natural group, best to be maintained as a genus.

Buesia cristata (H. & G.) Copel., comb. nov.

Hymenophyllum cristatum H. & G., Icones Fil. (1829), pl. 148.

I have not seen this, but it is described and figured with serrate margins, laciniate-dentate lips of involucre, globose receptacle, and longitudinally attached falcate foliar teeth on the rachis—a combination of characters marking it unmistakably as a *Buesia*. The involucre is pictured as quite exactly round. This seems to be the *Hymenophyllum fucoides* of Sodiro, and of Hooker and Baker in part; but it is not near that of Swartz.

Didymoglossum Lehmannii (Hieron.) Copel., comb. nova

Plate 49

Trichomanes Lehmannii Hieron., Bot. Jahrb., 34 (1904):420.

Rhizomate repente et intricato, 0.6 mm. crasso, nigro-piloso, demum subglabrescente; stipite 4–7 mm. longo, rhachique anguste alata inferne densissime nigro-pilosis, pilis crinitis simplicibus vel ramosis; fronde saepius ca. 8, rarius usque ad 12 cm. longa, 2.5–3.5 cm. lata, utrinque (sursum longius) angustata bipinnatifida, pinnis patentibus ellipticis obtusis; segmentis 1.5 mm. latis, 3 mm. longis, obliquis, obtusis, integris vel subserratis, obscure viridibus, herbaceis, costis inferne pilosis, marginibus setis atrocastaneis et simplicibus et stellatis usque ad 6-ramiferis ornatis; venulis deorsum attenuatis sed fere omnibus connexis, venula marginale carente; cellulis mediocris parietibus tenuibus; soris in apices pinnarum et segmentorum superiorium insertis, tubo lineare 1.7 mm. longo, sursum angustissime deorsum latius alato: labiis expansis vel recurvis, 1.7 mm. longis, 0.6 mm. latis, apice rotundatis, laete fuscis margine paullo obscuriore, cellularum parietibus incrassatis, receptaculo anguste filiforme 4 mm. longo.

Ecuador: Prov. Esmeraldas, Parroquia de Concepción, Playa Rica, on stems of shrubs in dense forest, alt. 100 m., Mexia No. 8450, Dec. 15, 1936; *Ibid.*, No. 8476a.

Related to *D. Kraussii*, distinct from all related species in form and size, and by the very slender tube and long lips of the involucre. *Trichomanes quercifolium* H. & G. *non* Desv., and *T. melanopus* Baker were described from Ecuadorean specimens, but I do not believe that this can represent either of them. It looks superficially like a *Lacostea* rather than a *Didymoglossum*.

After this plant and *Adiantum Kalbreyeri* (p. 303) were prepared for publication as new species, Dr. Maxon informed me of their identity, established by comparison with authentic originals. As I had been unable to recognize them by the original descriptions, it seems worth while to redescribe and illustrate them.

Didymoglossum lineolatum v. d. Bosch.

Peru: Huánuco, near confluence of Layumba and Huallaya rivers, alt. 795 m., on tree trunks, No. 8275.

Not hitherto reported south of Colombia; but Buchwald 98, distributed by Dr. Rosenstock, from Ecuador "in confinis Columbiae," as "*Trichomanes sphenoides* Kze. var. versus *T. lineolatum* Hk.," is like the Peru plant, and is *D. lineolatum* rather than *D. sphenoides*.

Plagiogyria Fialhoi (Fée et Glaz.) Copel. comb. nov.

Lomaria Fialhoi Fée et Glaz. in Fée, Cr. Vasc. Bras., I (1869) :239, t. 7, f. 2.

Brazil: Sierra do Itatiaya, alt. 2100–2200 m., A. C. Brade No. 14498; Santa Catharina, Spannagel No. 175, sterile in our material. I have supposed that the type of *Lomaria Fialhoi* was in Rio de Janeiro, but Dr. Brade is unable to find it there.

Very near to *P. semicordata* (Presl) Christ, with which it was combined by Baker, Syn. Fil. (1873), p. 182, who had already identified it as that species in Flora Brasiliensis. I have remarked (Philip. Jour. Sci., 38 [1929] :406) that *P. biserrata* Mett., described as from Colombia and Mexico, may have included two species. My present belief is that it is one, and varies from short-stipitate with pinnae broadest in the middle, as described, to long-stipitate (up to 30 cm.), with pinnae not at all dilated except at the base. We have it from Colombia, with fertile pinnae 3 mm. wide, and from Mexico with them 4 mm. wide. Those of Brade's plant cited above are only 2 mm. wide, except in respect to projecting ruptured sporangia.

This is geographically remote from any other known species of its genus—so far that, along with the recent discovery of *Plagiogyria* in New Guinea, it throws some doubt on my belief in the Japanese origin of American *Plagiogyria*. However, the resemblance of the American group, collectively, to *P. matsumuriana* remains a fact.

Woodsia jujuiensis Copel., sp. nov.

Plate 50

Stipite 5–8 cm. alto. subvalido, deorsum castaneo sursum stramineo puberulo glabrescente, basi rhizomateque breve paleis linearibus castaneis margine stramineis valde attenuatis vestitis; fronde 20–25 cm. longa, 4 cm. lata, utrinque angustata, subbipinnata, rhachi pilis debilibus fulvis vestita; pinnis sessilibus, medialibus rhachin versus pinnatis alibi pinnatifidis superne viridibus sparsius pilosis, inferne pilis albis crinitis vestitis, segmentis inciso-crenatis; venis furcatis marginem vix attingentibus; soris more Cheilanthis saepe protectis, indusio rupto fragmentis diaphanis margine plerumque crenatis.

Argentina: Prov. Jujuy, Rio Yala, 15 km. west of Yala, alt. 1900 m., on half-shady banks, James West No. 6253, March 8, 1936.

Nearest to *W. mollis;* more lanose and less stout than Mexican material of that species, and with more and much longer hairs than Andean specimens referable to it.

Woodsia pallida Copel., sp. nov.

Plate 51

Rhizomate breve, basibus 2 cm. longis stramineis stipitum paleisque lanceolatis attenuatis 2–3 mm. longis atrocastaneis rarius laete castaneo-marginatis profunde immerso; stipitibus dense fasciculatis, 2–4 cm. longis, 0.5 mm. crassis, basi parce paleatis sursum glabris rhachique albo-stramineis; fronde 6–11 cm. longa, 2–2.5 cm. lata, utrinque angustata, bipinnatifida, rhachi gracillima, sparse crinito-pilifera; pinnis subremotis, sessilibus, fere horizontalibus, apice rotundatis, basi truncatis paullo dilatatis, utraque facie haud dense piliferis, pallide viridibus, inciso-lobatis, lobis rotundatis obscure crenatis; soris 1 mm. latis, indusio membranaceo, in segmenta lata subfissa expansa persistentia ad basin fisso, conspicuo.

Argentina: Prov. Jujuy, 20 km. west of Humahuaca, alt. 3600 m., in rock crevices in half-shade, James West, U. C. Bot. Exped. No. 6339, March 13, 1936.

Probably nearest to *W. montevidensis;* distinguished from that and other species by the very slender, whitish rachises, large sori, and persistent, conspicuous indusium.

Dryopteris limaensis Copel., sp. nov.

Plate 52

Thelypteris, caudice erecto vero 6–8 mm. crasso cum basibus stipitum obtecto crasso, apice basibusque stipitum paleis paucis ovatis integris nudis castaneis vestitis; stipitibus ca. 5 cm. longis, puberulis, validis; fronde 30 cm. longa, 7 cm. lata, utrinque longe attenuata, bipinnatifida, subcoriacea, rhachi minute dense setulifera; pinnis medialibus horizontalibus, sessilibus, acutis, basi 1 cm. latis, fere ad costam pinnatifidis; segmentis 2 mm. latis, obtusis, integris, superne microscopice setuliferis, inferne venis setuliferis lamina vestamento amorpho microscopico tectis; venulis liberis simplicibus; soris supramedialibus, indusio setifero caduco, sporangiis nudis.

Peru: Dept. and Prov. Lima, road Chosica to Matucana, alt. 2100 m., near trickle at roadside, Mexia No. 04079, Oct. 20, 1935.

This has the aspect of *D. rivularioides,* from which it differs in pubescent surface and naked paleae; of *D. Stierii,* which has naked sori and setose sporangia; and is most like *D. subandina* C. Chr. & Ros. *forma minor* Ros., Buchtien No. 3119, of Bolivia, which has longer setae and more persistent indusia, and has not the peculiar microscopic scurfiness of the nether surface nor the microscopic setae of the upper one.

Dryopteris aequatorialis Copel., sp. nov.

Plate 53

Thelypteris, caudice erecto occulto; stipitibus fasciculatis 2–4 cm. altis; fronde 35 cm. alta, 7 cm. lata, acuminata, basi attenuata, rhachi straminea costisque parce piluliferis; pinnis infimis ad vestigia reductis, sequentibus deltoideo-3–5-ramiferis, medialibus approximatis, sessilibus, distantibus, e basi oblique dilatata sensim ad caudam longam integram attenuatis, basin versus fere ad costam pinnatifidis, segmento infimo acroscopico valde elongato ad rhachim appresso, sequentibus angulo 45° distantibus, vix ultra 1 mm. latis, acutis, plerisque falcatis, inferne inconspicue glanduliferis; venulis 5–6-paribus, inferioribus soriferis; soris supra-medialibus, parvis; indusio minuto, hyalino, setulifero, sporangiis nudis.

Ecuador: Esmeraldas, below Playa Rica, alt. 100 m., on river banks, often submerged, Mexia No. 8486, Dec., 1936.

Nearly related to *D. sancta.*

Dryopteris lomatosora Copel., sp. nov.

Plate 54

Thelypteris, caudice adscendende valido, basibusque stipitum caespitosorum paleis ovatis fuscis attenuatis 3 mm. longis parce et minute ciliatis vestitis; stipitibus stramineis, gracilibus, 20–30 cm. (ad pinnas normales) altis, deorsum minutissime sursum longius pubescentibus; fronde 45 cm. longa, 17 cm. lata, utrinque attenuata, rhachi costisque conspicue pubescentibus, pinnis infirmis valde remotis et reductis paucis; pinnis inferioribus

normalibus basi rotundatis, medialibus sessilibus basi truncatis vix dilatatis, horizontalibus, acuminatis, ca. 17 mm. latis, fere ad costam pinnatifidis; segmentis late patentibus, rectis vel subfalcatis, obtusis, 2 mm. latis, herbaceis, venis pilis longis albis ornatis, lamina minute setulifera; venulis ca. 8-paribus: soris fere marginalibus; indusio minuto setis longis praedito, sporangiis nudis.

Peru: Huánuco, Dist. Churubamba, Hacienda Mercedes, alt. 2020 m., Mexia No. 8187.

Most like the Brazilian *D. Lindmani* C. Chr.

Dryopteris Herzogii Rosenstock, Med. Rijks Herb. Leiden, No. 19 (1913) :15.

Peru: Huánuco, Dist. Churubamba, alt. 1500 m., Mexia No. 8153.

Rhizome creeping, rather naked; stipe 85 cm. tall, bright brown, with very sparse small scales; frond 1.6 m. long, almost naked; pinnae horizontal, remote, 25 cm. long, 3 cm. wide, sessile with an inconspicuous trace of an aerophore; veinlets about 16 pairs; sori medial. This agrees with our fragment of the type collection better than with the description.

Dryopteris semihastata (Kunze) O.K., C. Chr. Monog. Dryopt., I (1913) : 226.

Aspidium, Kunze, Linnaea, 9 (1834) : 91.

The original description of this species, based on Pöppig No. 243, includes mention of remarkable roots, a foot long, and states that the sori are in lines or rows, one on each half-pinna. The preceding fern in Kunze's list, No. 242, collected at the same place and presumably at the same time, was *Nephrolepis pectinata.* A specimen in the fern herbarium of Professor A. Schnitzlein, now in the Herbarium of the University of California, "misit Dr. Pöppig 1836," is labeled *Aspid. semihastatum,* with a question if it be not *A. pectinatum* W.—which it really is. The two being mixed in Pöppig's hands, it is probable that Kunze also received and described a mixture; which accounts for the two statements noted above, applicable to the *Nephrolepis* but not to the *Dryopteris.*

Polystichum Mexiae Copel., sp. nov.

Plate 55

P. gregis P. aculeati exindusiatum, rhizomate crasso adscendente paleis magnis atrocastaneis ovatis acuminatis decidue ciliato-fimbriatis vestito; stipitibus 50 cm. altis, gracilibus, basi paleis descriptis aliisque multo minoribus ferrugineis lanceolatis margine fimbriatis vestitis, sursum stramineis paleis minoribus sparsis colore et forma diversis vestitis; fronde 50–60 cm. longa, 20–25 cm. lata, acuminata, bipinnata, rhachi paleis paucis atrocastaneis lanceolatis usque ad 6 mm. longis et multis ferrugineis linearibus parce spinuliferis vestita; pinnis contiguis medialibus horizontalibus 10–14 cm. longis, ca. 16 mm. latis, in acumina longa inciso-serrata protensis, rhachillis praecipue rhachin versus paleis formae minoris vestitis; pinnulis subsessilibus, contiguis, oblique rhomboideis, ca. 8 mm. longis et 4 mm. latis, margine rhachiscopico convexo, obscure vel rarius argute auriculatis, mucronatis, apicibus marginibusque acroscopicis serrulatis, firmo-papyraceis, omnino planis, superne viridibus nudis, inferne pallidis squamulis deciduis paucis costalibus exceptis glabris; soris inframedialibus, parvis, utroque latere costae ca. 3.

Ecuador: Prov. Pichincha, Canton Quito, road Nono to Mindo, alt. 3150 m., Mexia No. 7679, Sept. 13, 1935.

The group is richly developed in the Andes, but I cannot even approximately identify this with any described species. Such species are:

P. cochleatum (Kl.) Hieron, coriaceous and with strongly convex pinnules.

P. pycnolepis (Kl.) Moore, or Hieron., and the similar or identical *P. gelidum* (Kunze) Fée, also coriaceous and more or less convex. These have been reduced to *Jamesonia paleacea,* the type of which, Linden 505, was cited by Hooker under his *Polypodium pycnolepis.*

P. Lehmannii Hieron., more slender than *P. cochleatum,* which is itself more so than *P. Mexiae.*

P. Wolfii Hieron., with rachises naked beneath.

P. yungense Ros., with ovate pinnules everywhere conspicuously fine-toothed.

P. opacum Ros., "paleis numquam nigrescentibus."

Polypodium rigidum H. & G., *non* Hoffmann, identified with *Polystichum polyphyllum* Presl, coriaceous and with contiguous sori; those of *P. Mexiae* are separated by at least their own width.

A fragment in the Herbarium of the University of California collected by Sodiro in 1902 at Angamarca may be old *P. Mexiae* with the paleae lost; on the same sheet is one pinna of still another species.

Polystichum pygmaeum Copel., sp. nov.

Plate 56

Rhizomate breve, crasso, adscendente, et basibus stipitum et paleis brunneis ovatis magnis breviter ciliatis immerso; stipitibus caespitosis, 2.5 cm. altis paleis paucis ovatis acuminatis cum minutis et fibrillosis haud densis interspersis vestitis; fronde maxima visa 9 cm. longa, 18 mm. lata, bipinnata, rigide coriacea, rhachi primo ut stipes paleata demum glabrescente et punctis castaneis ornata; pinnis majoribus medialibus et inframedialibus horizontalibus vel deflexis, rectis, fere aequilateralibus, brevissime pedicellatis, 9 mm. longis, basi 5 mm. latis, rhachibus paleis perpaucis latis et angustis aliquot sparse ciliatis et filiformibus adspersis, etiam venis inferne sparse piliferis, segmento apicale 4–5 mm. longo triangulare mucronato argute dentato, basi utroque latere lobo uno praedito, pinnulis acroscopicis plerumque 2, basiscopica una, oblique rhomboideo-ovatis, mucronatis et mucronato-dentatis, marginibus ubique revolutis; soris paucis, orbicularibus, castaneis, indusio inviso, verosimiliter carente.

Bolivia: 13 km. south of Tiahuánaco, alt. 4200 m., in rock crevices in half-shade, James West, U. C. Exped. No. 6393, March, 1936.

Obviously derived from some much larger species of the group of *P. cochleatum,* but not identifiable with any species of more normal size. *P. pumilio* Maxon, of Ecuador, is a less reduced plant of somewhat different probable affinity.

Asplenium Mexiae Copel., sp. nov.

Plate 57

Filicula gregis A. formosi, stipitibus caespitosis ca. 1 cm. altis, rhachibusque atris nitentibus castaneo-alatis; fronde lineare usque ad 8 cm. alta et 1.4 cm. lata, utrinque angustata, glabra, rigidula, viride, pinnata, apice brevissima pinnatifida; pinnis utroque latere usque ad 22, sessilibus, infimis minutis flabellatis, medialibus 5–7 mm. longis, 3 mm. latis, trape-

soideis, lamina basiscopica fere carente, marginibus inferioribus et rhachiscopicis integris, aliis inciso-laciniatis, lobis parvis acutis; venis immersis; soro solitario, maximo, indusio lato, ad venam margini inferiori parallelam affixo, demum ultra marginem deflexo.

Brazil: Minas Geraes, near Diamantina, slope of Serra do Anjico, in open scrubby wood, alt. 675 m., Mexia No. 5609a, mixed with *Anemia*, in Herb. Univ. Calif. No. 476333.

This has the stature and some other characteristics of a small *Asplenium Trichomanes;* but the form and dissection of the pinnae mark it as a very reduced relative of *A. formosum*. In spite of the very large solitary sori, it is not immediately related to *A. monanthes*.

***Asplenium holophlebium* Baker**

Ecuador: Esmeraldas, Playa Rica, alt. 100 m., Mexia No. 8481; identification confirmed by Alston: "Apparently starts as terrestrial plant, then becomes epiphytic, running up slender sticks in forest."

The published description fits the fertile fronds. The sterile fronds range from flabellate-dichotomous, with four or more equal lobes 3–4 mm. wide, shallowly or deeply separated, through all intermediates to pinnate with pinnae 1.5–2 mm. wide, the last being the form commonly fertile.

Besides confirming this identification, Alston notes that *A. filicaule* Baker is the same species.

Nephrolepis pectinata (Willd.) Schott.

Peru: Huánuco, on trunks and rocks over Huallaga River, alt. 800 m., Mexia No. 8324, "Occasionally reaches 1.5 m. in length."

Cheilanthes tripinnata Copel., sp. nov.

Plate 58

C. squamosae Gillies persimilis, frondibus tripinnatis, pinnulis[II] cucullato-orbicularibus parvis superne ad costam piliferis distincta.

Peru: Dept. Apurimac, Quebrada of Juccuchic-chupan, on trail Chincheros to Andahuaylas, in rock crevices, alt. 4200 m., James West No. 3724, Nov. 3, 1935.

This is a near relative of *C. myriophylla* Desv., from which it differs in the paleae—broad on stipe and other axes and ciliate. Also, it is near to *C. scariosa* (Swartz) Presl, but broader, again pinnate, and with somewhat different paleae. The synonymy of the group is confused. It begins with *Acrostichum scariosum* Sw. Presl, 1825, transferred this to *Cheilanthes,* but applied it to a much more dissected plant, not failing to note the discrepancy. Consequently Christensen, Index, p. 179, notes "certe non Acrostichum Sw. 1806; nomen malum." But it must be Swartz's species, and is then a good name, whatever fern Presl had in hand. Apparently, Desvaux made the same transfer in 1827, perhaps for the right fern, which is a *Cheilanthes,* even if twice named *Notholaena.* But a much more slender fern, bipinnate with cucullate pinnules, seems to me more likely to own this name than does *C. squamosa* Gillies, Hooker and Greville, plate 151.

Pellaea peruviana Copel., sp. nov.

Plate 59

Rhizomate breve, ca. 3 mm. crasso, paleis ferrugineo-castaneis 5 mm. longis lanceolatis planis vel undulato-crinitis integris immerso; stipitibus approximatis, 5–8 cm. altis, rhachibusque nigris, nitidis, glabris, teretibus; fronde 10 cm. alta, 4 cm. lata, tripinnata, glabra, subcoriacea; pinnis patentibus, ovatis; pinnulis terminalibus ellipticis, 5 mm. longis, 2 mm. latis, apice rotundatis, basi aut integris et cuneatis, aut lobis lateralibus 1 vel 2 praeditis; pinnulis inferioribus brevipedicellatis deltoides vel ovatis; pinnuls" 1–3-paribus, parvis, planis, plerisque sessilibus, basi truncatis vel rarius late cordatis, infimis integris vel furcatis; venis omnino inconspicuis; indusio continuo, lato, margine integro vel crenulato.

Peru: Dept. Apurimac, near Abançay, collected by pupils of Professor Victor Santander C., of Colégio Grau.

Nearest to *P. pulchella* (Mart. et Gal.) Fée, but less coriaceous, with longer segments, mostly noncordate, and shorter-stalked divisions of every rank. I have not seen *P. myrtillifolia* Mett., but the reasons given for its separation from *P. pulchella* do not apply at all to *P. peruviana*.

Pteris nuda Copel., sp. nov.

Plate 60

Litobrochia Pt. decurrenti affinis, rhizomate breve valido apice paleis castaneis attenuatis 4 mm. longis vestito; stipite 70 cm. alto, stramineo, glabro, inerme, sicco vix 4 mm. crasso; fronde 1 m. alta, 60 cm. lata, bipinnatifida, glabra, herbacea, pinnis apicalibus et basalibus ultra 60 cm. longis, 8–10 cm. latis, lateralibus ca. 7-paribus paullo minoribus, subsessilibus basi brevissime decurrentibus, apice longe attenuatis, ad alam latam pinnatifidis, sinubus rotundatis, segmentis 8 mm. latis, apice serrulatis; areolis secus costas pinnarum haud angustatis inter costulis et margines plerumque biseriatis.

Peru: Huánuco, forested bank of Riochuela Chuntalagua near confluence with Rio Huallaga, alt. 820 m., Mexia 8299.

Of a considerable number of fronds, a single one has a forked basal pinna. This differs from *Pteris gigantea,* collected in the same region by Mrs. Mexia, as well as by others, in the plan of frond, not pedate nor, with the one exception, even with a forked basal pinna. *P. crassipes* Agardh would seem to be similar in plan, though now construed as *P. gigantea;* these very large ferns might be variously described from fragments, but in this case Agardh seems to have had an entire frond. At any rate, the stipe and rachis of *P. nuda* are remarkably slender, in distinction to his "digitum crassus"; and the costal areoles are dilated instead of hardly visible. *P. decurrens* Presl is not normally naked, though Rosenstock referred to it a var. *glaberrima* from southern Brazil; it has forked basal pinnae, the pinnae more deeply pinnatifid, the segments narrower and relatively remote.

Adiantum delicatulum Mart.

Peru: Dept. Cuzco, Prov. La Convención, valley of the Vilcanota, road Macchu-Picchu to Quillabamba, 153 km., alt. 1300 m., on damp road bank in shade, Mexia No. 8088a.

New to Peru. Part of the material conforms perfectly to that from Brazil. The pinnae of other fronds bear broader sori, flanked by prominent teeth, as

in *A. deflectens,* from which it can still be distinguished by fewer and remote pinnae and the very prolonged rooting apices.

A. boliviense Christ & Ros.

Peru: Dept. Cuzco, Prov. La Convención, valley of Sambray, alt. 1200 m., Mexia No. 8033, "common."

Apparently new to Peru; exactly like Bolivian specimens, Buchtien No. 5036, and sufficiently like Buchtien No. 459.

The minute orange glandular trichomes on the nether surface are diagnostic.

Adiantum Mexiae Copel., sp. nov.

Plate 61

Stipite ultra 1 m. alto, rhachibusque atris, nitidis, glabris; fronde 60–80 cm. longa, deltoidea, tripinnata, pinnis bipinnatis 1–2-paribus, pinnatis 3–5 paribus, omnibus stipitatis, pinnatis 25–35 cm. longis, 5 cm. latis; pinnulis utroque latere rhacheos ca. 40, 25–30 mm. longis, 7–8 mm. latis, sessilibus, dimidiatis, glabris, papyraceis, marginibus acro—et basiscopicis parallelis fere rectis integris, apice rotundatis obscure denticulatis, venis inconspicuis; soris secus marginem acroscopicum contiguis, multis (usque 15), indusio obreniforme-orbiculare.

Peru: Huánuco, in virgin forest near confluence of rivers Cayumba and Huallaga, alt. 860 m., Mexia No. 8292, Oct., 1936.

Near *A. polyphyllum,* from which it is distinguished by the total absence of incisions in the acroscopic margin; also, the texture is firmer and the pinnules more crowded.

Adiantum Kalbreyeri C. Chr.

Plate 62

A. pilosum Baker, Ann. of Bot., 5 (1891): 207, *non* Fée.

Stipite 60–75 cm. alto, atro, nitido, sursum rhachibusque brevissime fusco-puberulis; fronde 30–40 cm. longa, ovata, bipinnata, pinnis utroque latere plerumque 2, stipitulatis, caudatis, ca. 20 cm. longis, 4 cm. latis; pinnulis subsessilibus, majoribus 3 cm. longis, 1 cm. latis, dimidiatis, trapeziformibus, acutis, glabris, papyraceis, venis conspicuis, marginibus acroscopicis et exterioribus leviter incisis soriferis; soris apices loborum brevium complentibus, indusiis obreniformi-orbicularibus, 1.5–2 mm. latis.

Peru: Huánuco, Dist. Churubamba, Hacienda Mercedes, in forest above Cayumba River, alt. 1200 m., Mexia No. 8175, Sept., 1936.

Suggestive of *A. pectinatum,* but distinguished from that and other species by the few and strictly unbranched primary pinnae. The large round indusia are another conspicuous feature.

Elaphoglossum craspedotum Copel., sp. nov.

Plate 63

Caudice erecto, valido, radicibus basibusque stipitum et paleis atrocastaneis parvis angustis integris obtecto; stipitibus fasciculatis, paleis brunneis parvis et ovatis et amorphis vestitis, 1.5 mm. crassis, frondium sterilium 8–10 cm. fertilium 20–25 cm. altis; fronde sterile 60 cm. longa, 3–4 cm. lata, acuminata, decurrente, papyracea, viride, costa deorsum

squamulosa, alibi glabra, margine angusto brunneo-hyalino primo continuo mox in fragmenta lacera parva rupto cincta; venis patentibus prope marginem incrassatis et terminantibus; fronde fertile ca. 20 cm. longa, 15 mm. lata.

Peru: Huánuco, Dist. Churubamba, Hacienda Mercedes, in forest in dense shade, alt. 1200 m., Mexia No. 8177, Sept., 1936.

Resembling *E. longifolium,* from which and from *E. subarborescens* it is distinguished by the small, dark, narrow paleae and more squamulose stipes.

Polypodium blepharideum Copel., sp. nov.

Plate 64

Ctenopteris, rhizomate breve adscendente, paleis fulvis integris nudis lanceolatis plerisque obtusis 1.4 mm. longis vestito; stipitibus approximatis, 2 cm. longis, gracilibus, setis rufo-castaneis 1–2 mm. longis horizontalibus obsitis; fronde ca. 10 cm. longa, 6 mm. lata, utrinque angustata, subpinnata, ubique sed praecipue ad apices segmentorum setosa; segmentis patentibus, 1.5 mm. latis, subrigidis, integris, costis indivisis, monosoris, vix aut ne vix ala connexis; soris parvis basalibus.

Peru: Huánuco, Dist. Churubamba, Cresta Santo Toribio, on trunk in dense forest, alt. 2000 m., Mexia No. 8147a, Sept., 1936.

Group of *P. trichomanoides,* distinguished by naked paleae and setose fronds, and strictly simple veins in the segments.

Polypodium Ratibori Copel., sp. nov.

Plate 65

Rhizomate ca. 2 mm. crasso, late (sub manu, 10 cm.) repente, paleis 2–2.5 mm. longis supra basin ovatum 0.75 mm. latum lanceolato-attenuatis atrocastaneis margine primo cinereo deinde castaneo remote dentato; stipitibus 2–30 mm. inter se remotis, 5–55 mm. longis, primo paleis obtectis demum glabrescentibus; fronde 20–34 mm. longa, 8–12 mm. lata, haud deltoidea, acuta, basi brevi-decurrente, crasse coriacea, opaca, oblique pinnatifida, superne glabra, inferne paleis castaneis basi peltato 0.7–0.9 mm. latis deinde acuminatis 1.4–2.0 mm. longis dentatis primo imbricatis vestita; segmentis 3–5 mm. longis, 2.5 mm. latis, integris vel undulatis, acutis; venis immersis, liberis; soris 1–3-paribus, demum confluentibus, castaneis.

Argentina: Prov. Jujuy, 20 km. west of Humahuaca, alt. 3000 m., in deep shade of rock crevices, James West (de Ratibor Princeps), U. C. Bot. Exped. No. 6326, March 13, 1936.

Evidently a reduced species. The wide range in dimensions, especially in length of petiole, is natural in a plant growing in crevices, petioles more than 2.5 cm. long being presumably on plants in crevices deep enough to impair the illumination. The mass color of the paleae of the rhizome is dark chestnut; on the fronds, chestnut. The dark, medial part of the scale is broad, but not sharply delimited. The broad bases of the scales are bordered by a row of cells much elongate perpendicularly to the margin.

This is distinguished from related species by its extreme reduction, acute segments, and by having the lowest segments at most as long as the next lowest. Further, it is distinguishable from:

P. subvestitum Maxon (cotype) by darker, narrower paleae on the rhizome and darker paleae on the frond.

P. bryopodum Maxon (cotype), by darker paleae on the rhizome, median line with smaller cells and thicker walls, those of the frond darker and more abundant; with respect to the abundance, one may not be sure, because many have fallen from old fronds of *P. Ratibori*, and we may not know young fronds of *P. bryopodum*.

P. pycnocarpum C. Chr., as interpreted by Maxon, Cont. U. S. Nat. Herb., 17 (1916) : 569, by fronds narrower at base and ascending segments.

Polypodium appressum Copel., sp. nov.

Plate 66

Goniophlebium sensu Preslii non Blumei, rhizomate scandente, 4 mm. crasso, paleis magnis imbricatis appressis orbiculari-ovatis apicibus brevibus caducis basibus late peltatis fere nigris marginibus brunneis scariosis obtecto; stipite stramineo, 25 cm. longo, nudo; fronde 45–50 cm. longa, 20–25 cm. lata, impari-pinnata, rhachi sparse pilosa deorsum glabrescente; pinnis subopposítis, inferioribus sessilibus basi cuneatis, supremis adnatis, 10–12 cm. longis, 3 cm. latis, acuminatis, integris, papyraceis, ciliatis et ubique haud dense pilosis; areolis sorisque magnis superficialibus plerumque tri-seriatis.

Bolivia: Dept. La Paz, Prov. Sur Yungas, Colaya, alt. 1780 m., on tree trunk in virgin forest, Mexia No. 7821.

Distinguished from most of its relatives by its pilose leaves; from *P. chnoodes*, by the narrow bases of the pinnae. Named for the strictly appressed scales of the rhizome, with large, almost black, round to oblong affixed bases and fairly broad, free, brown borders.

Eschatogramme subnuda (C. Chr.) Copel., comb. nov.

E. furcata var. *subnuda* C. Chr., Dansk Bot. Arkiv, 6 (1929) : 36.

Lamina frondis fere glabra, costa inferne squamulis paucis ornata, venis sterilibus liberis.

Christensen calls attention also to the long, narrow segments.

The specimen cited as the type is Buchtien 3586 from Polo Polo, Bolivia; we have a Buchtien specimen from Polo Polo, distributed as No. 130 by Dr. Rosenstock, which represents the type well, whether or not of the same collection. Also, slightly larger and even more naked, Mexia No. 8220, Peru: Huánuco, Dist. Churubamba, Hacienda Mercedes.

Dryopteris rudiformis C. Chr., sp. nov.

Thelypteris (Lastrea) rhizomate decumbente vel breviter repente, paleis brunneis pilosis sat dense vestito. Stipite stramineo, ad auriculas infimas usque ad 25 cm. longo, brevissime et decidue piloso. Lamina lanceolata, ad 60 cm. longa 10–12 cm. lata, versus basin more D. oligocarpae attenuata, coriacea, griseo-viridi, bipinnatifida; rachi dense et brevissime puberula. Pinnis inferioribus oppositis, sessilibus (aërophoris nullis), infimis 3–4-jugis auriculiformibus vel subglanduliformibus, remotis, maximis 4–5–6 cm. longis, 1 cm. latis, acuminatis, profunde pinnatifidis; segmentis parum obliquis, integris, obtusis, marginibus revolutis, basi 1–1.5 mm. latis, basalibus aequalibus vel parum auctis; paginis utrisque pilis brevibus griseis ubique hirtis, inferiori—praesertim ad costulas—glandulis sessilibus,

globosis, rubinis praedita; venis 7–9-jugis, indivisis, superne prominulis. Soris suprame-dialibus, parvis exindusiatis (?), receptaculo setoso; sporangiis glabris.

Ecuador: Prov. Pichincha, Canton Quito, Hacienda "La Merced," arid, brushy hill slope, alt. 3048 m., common, Mexia No. 7692, Sept. 14, 1935 (type in Herb. C. Chr.).

A species of the group of *D. oligocarpa* and *D. concinna* with short-attenuate lamina and long stipe, characterized by coriaceous texture (therefore resembling somewhat small forms of *D. rudis*); among the species with glabrous sporangia and short-puberulous rachis it is near *D. muzensis* Hieron. but certainly not the West Indian *D. scalpturoides.* It was evidently referred to *Nephrodium conterminum—Dryopteris opposita* (Vahl) Urban—by Sodiro (Cr. Vasc. Quit., p. 232).

PLATES

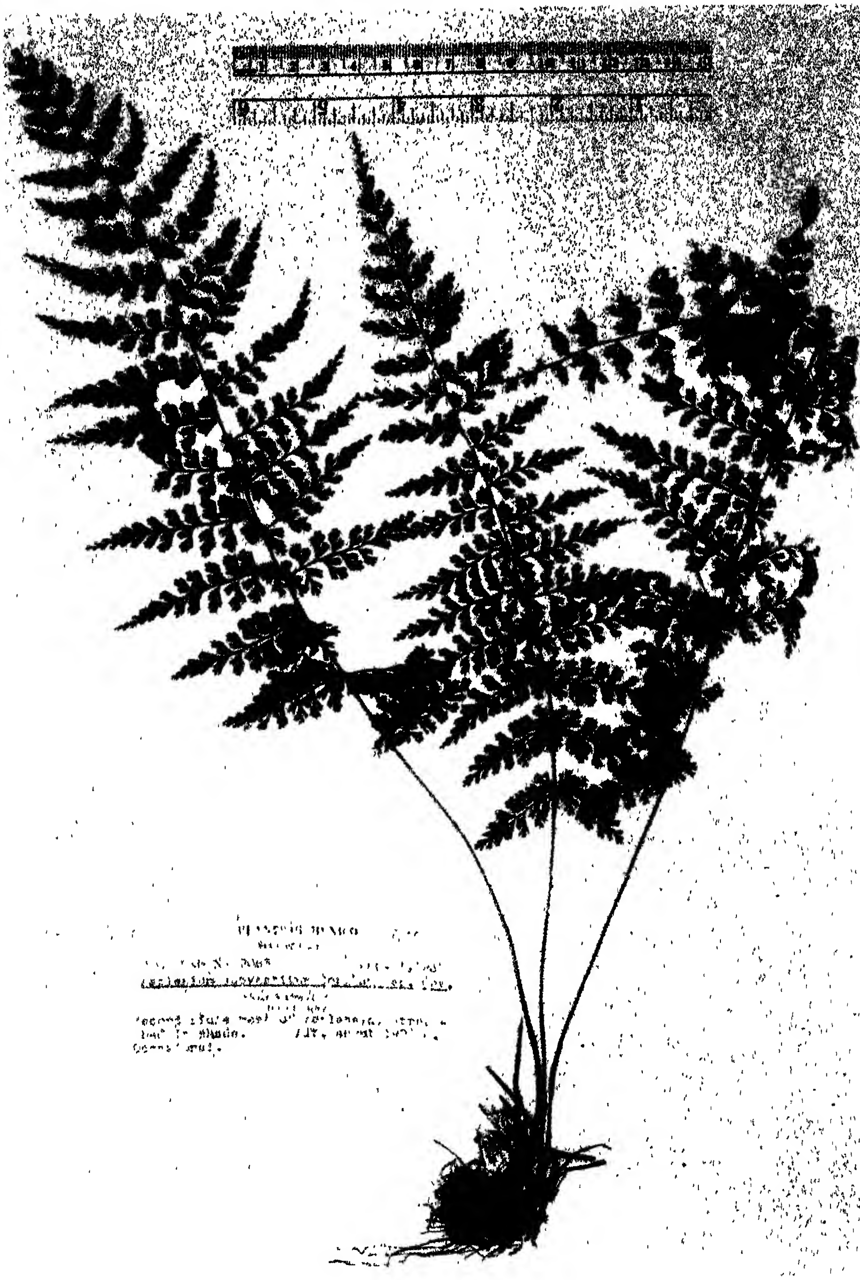
With three exceptions, illustrations are photographs of types. The type of *Polypodium pleolepis* is in the United States National Herbarium. Those marked with an asterisk are in the author's herbarium. All others are in the Herbarium of the University of California.

Athyrium Skinneri Moore
Dryopteris polyphylla Copeland*
Blechnum subdimorphum Copeland*
Asplenium subvestitum Copeland
Asplenium pinnatum Copeland
Pteris inflexa Copeland*
Polypodium sursumcurrens Copeland*
Polypodium cyathicolum Copeland*
Polypodium Villagranii Copeland*
Polypodium colysoides Maxon & Copeland*
Polypodium pleolepis Maxon & Copeland
Lycopodium Mexiae Copeland
Mecodium Mexiae Copeland
Didymoglossum Lehmannii (Hieron.) Copel.
Woodsia jujuiensis Copeland
Woodsia pallida Copeland
Dryopteris limaensis Copeland
Dryopteris aequatorialis Copeland
Dryopteris lomatosora Copeland
Polystichum Mexiae Copeland
Polystichum pygmaeum Copeland
Asplenium Mexiae Copeland
Cheilanthes tripinnata Copeland
Pellaea peruviana Copeland
Pteris nuda Copeland
Adiantum Mexiae Copeland
Adiantum Kalbreyeri C. Christensen
Elaphoglossum craspedotum Copeland
Polypodium blepharideum Copeland
Polypodium Ratibori Copeland
Polypodium appressum Copeland

Athyrium Skinneri Moore

Dryopteris polyphylla Copeland*

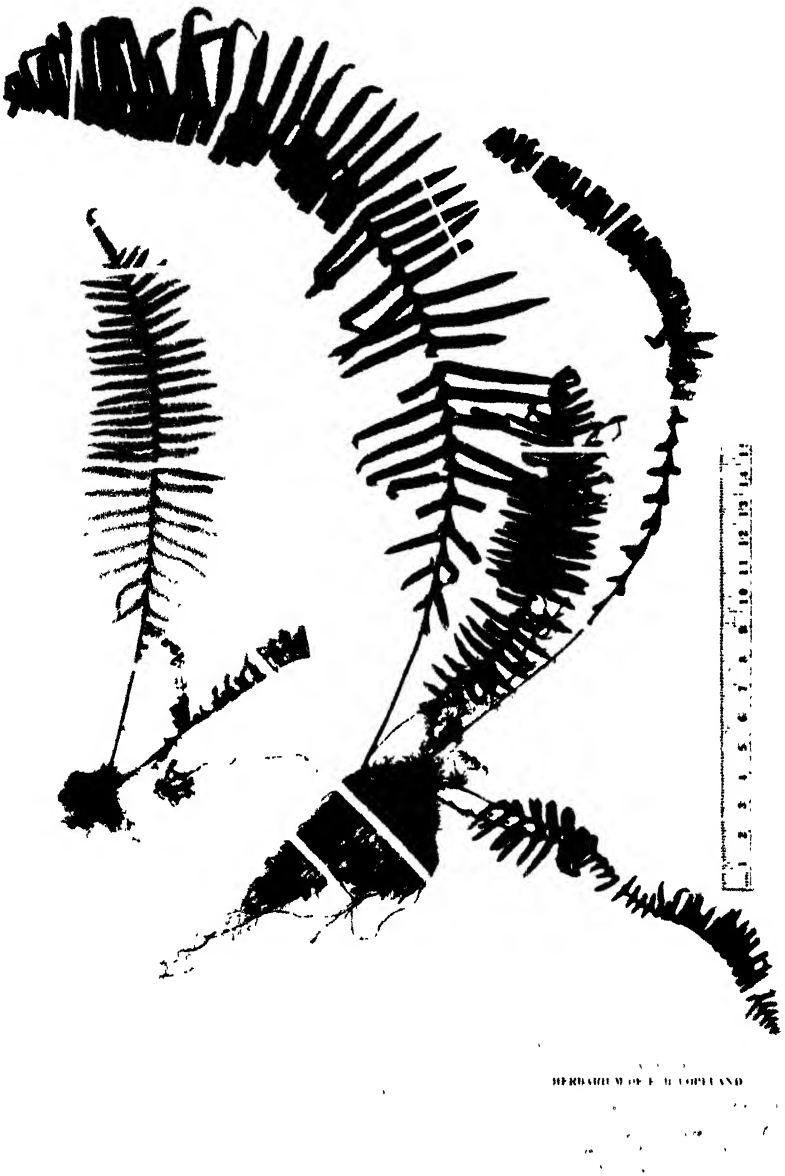
Blechnum subdimorphum Copeland*



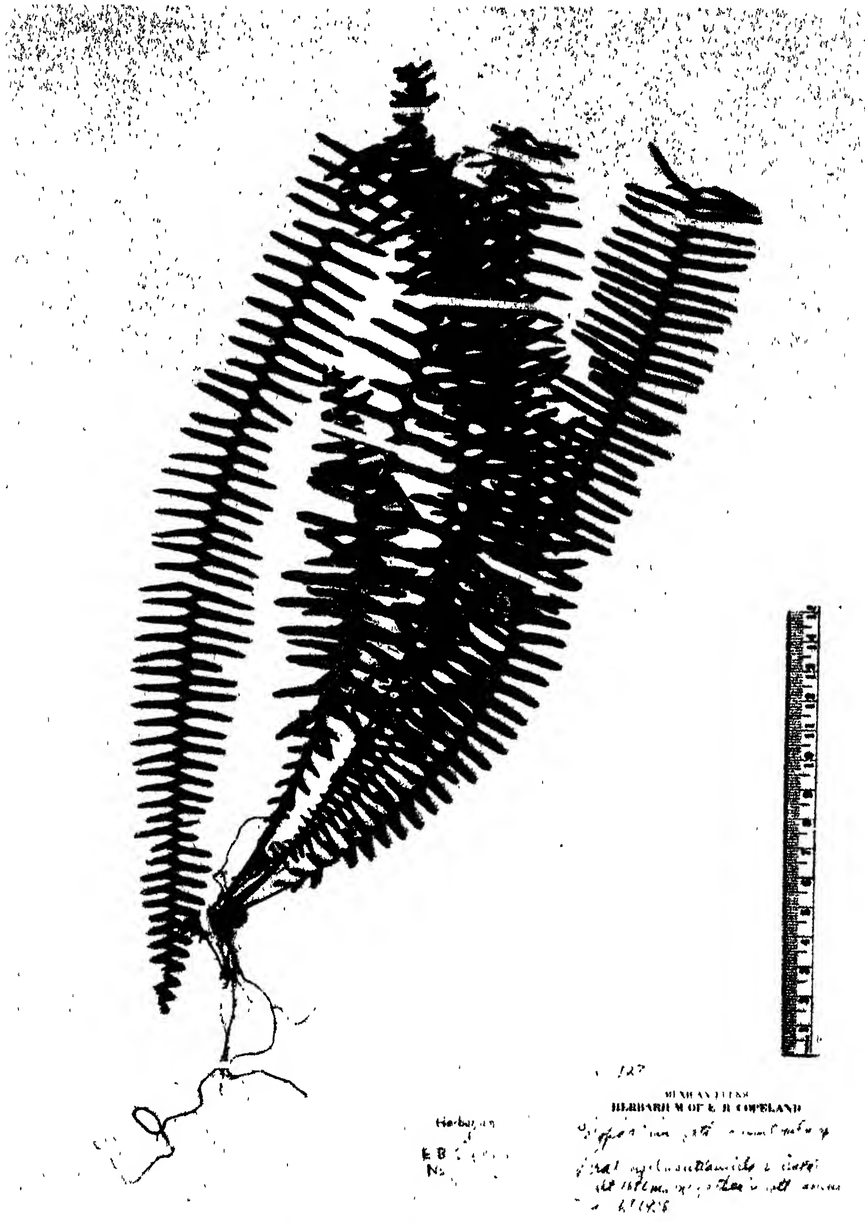
Asplenium subvestitum Copeland

Asplenium pinnatum Copeland

Pteris inflexa Copeland*



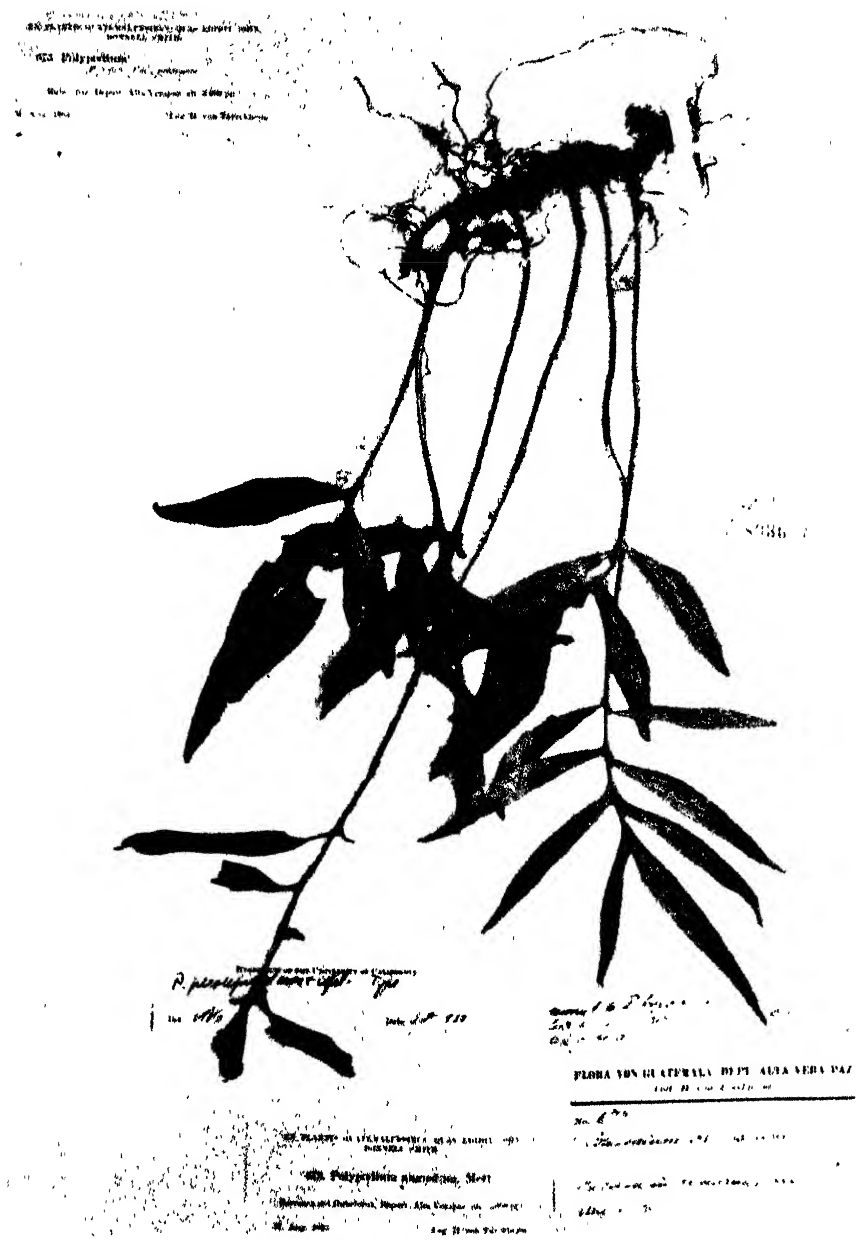
Polypodium sursumcurrens Copeland*



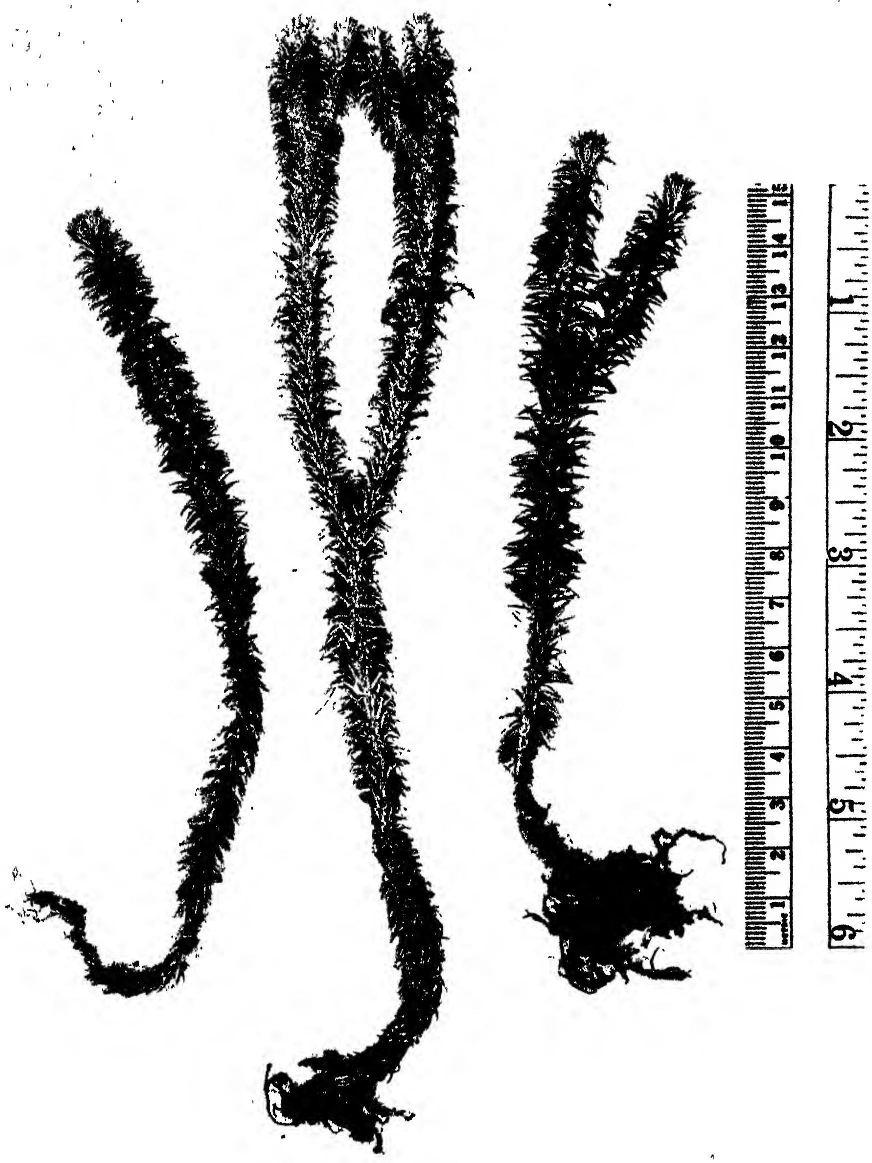
Polypodium cyathicolum Copeland*

Polypodium Villagranii Copeland*

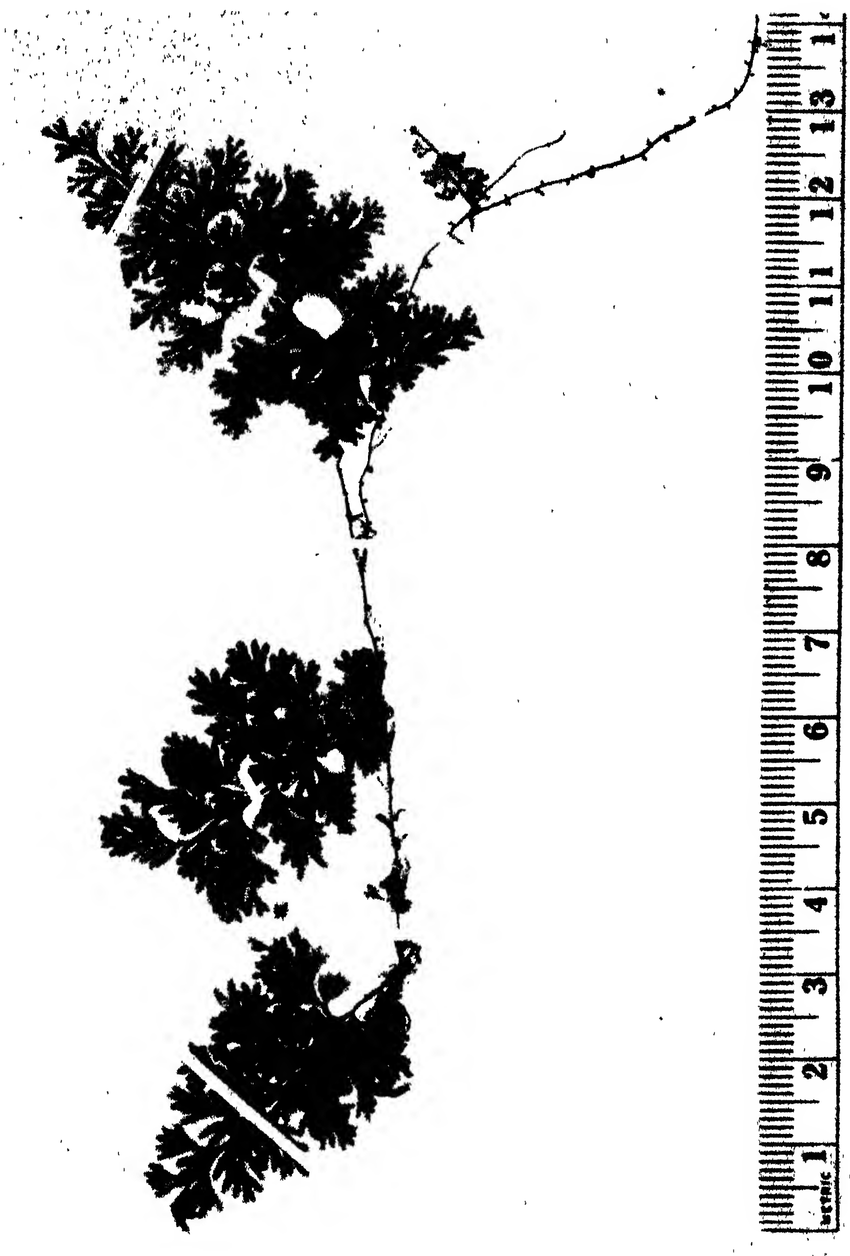
Polypodium colysoides Maxon & Copeland*



Polypodium pleolepis Maxon & Copeland



Lycopodium Mexiae Copeland

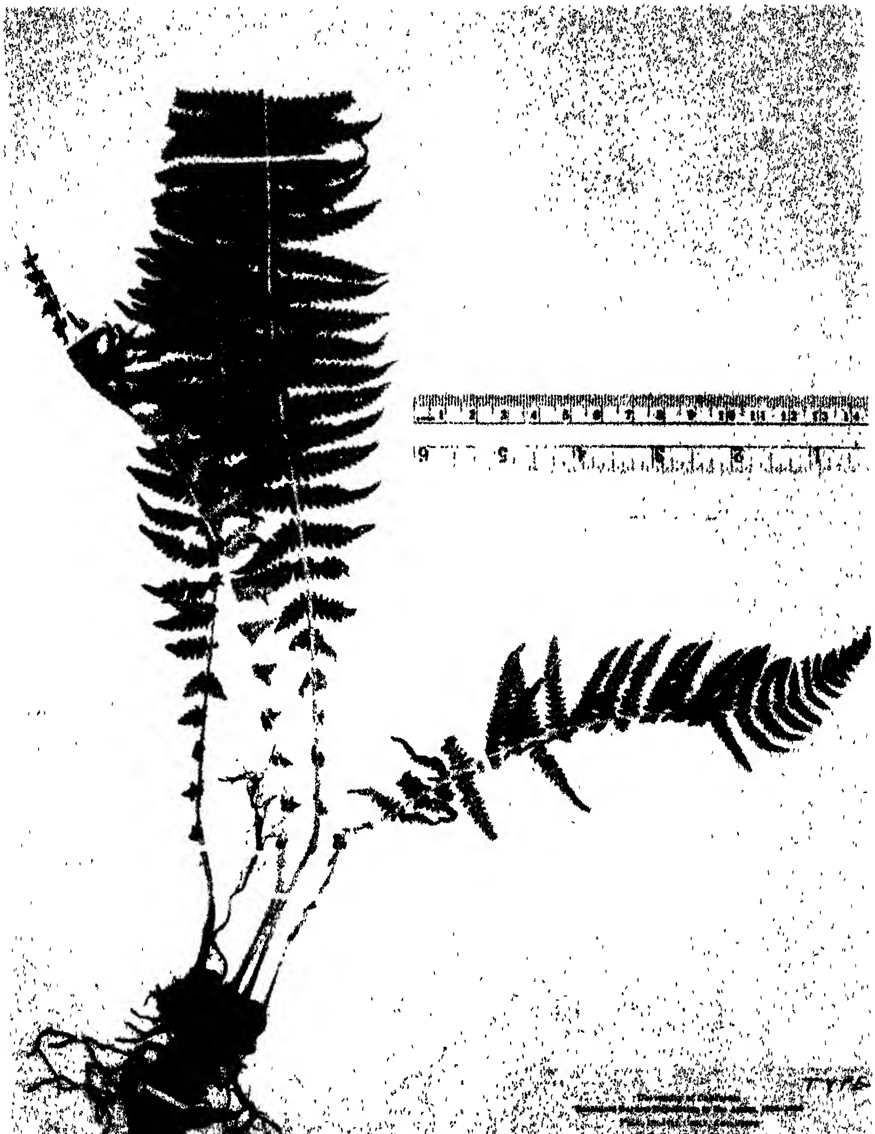


Mecodium Mexiae Copeland

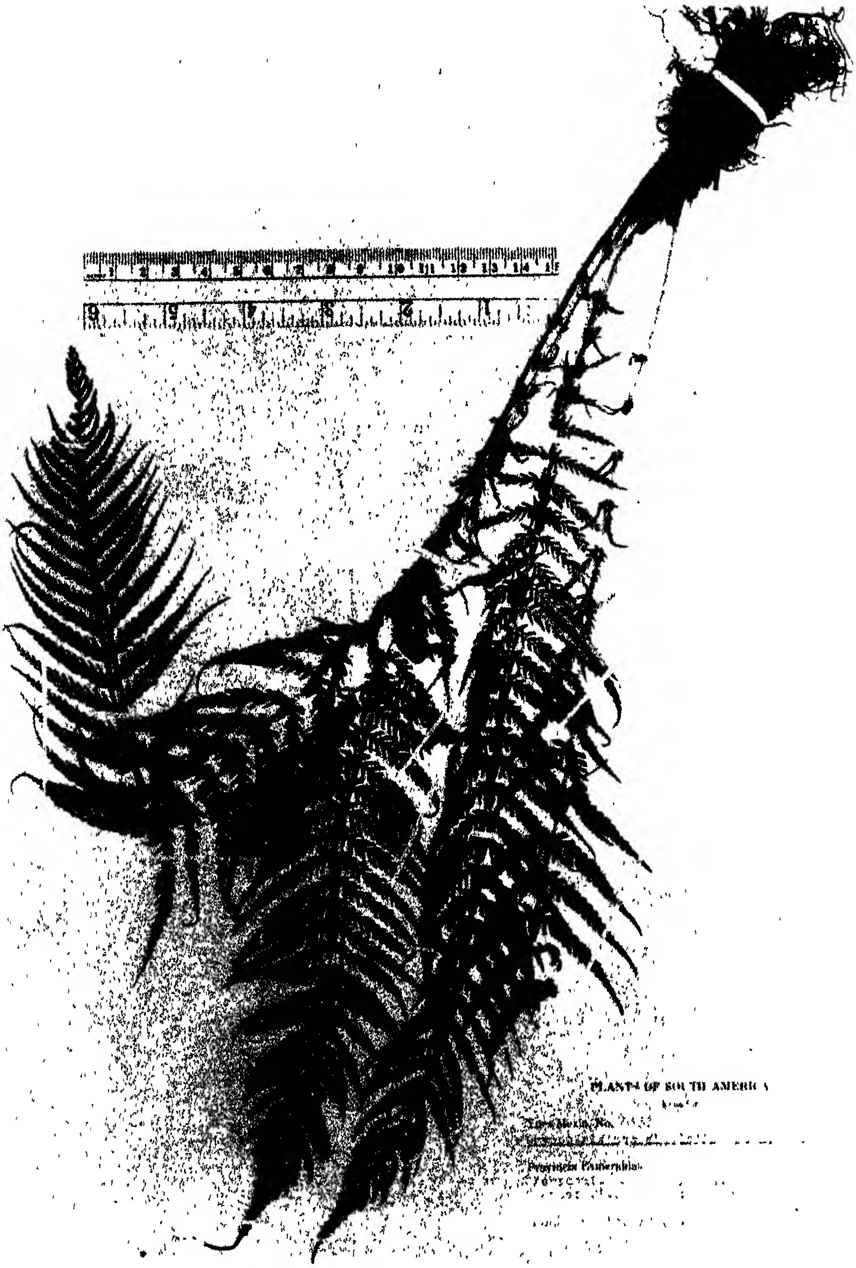
Didymoglossum Lehmannii (Hieron.) Copel.

Woodsia jujuiensis Copeland

Woodsia pallida Copeland

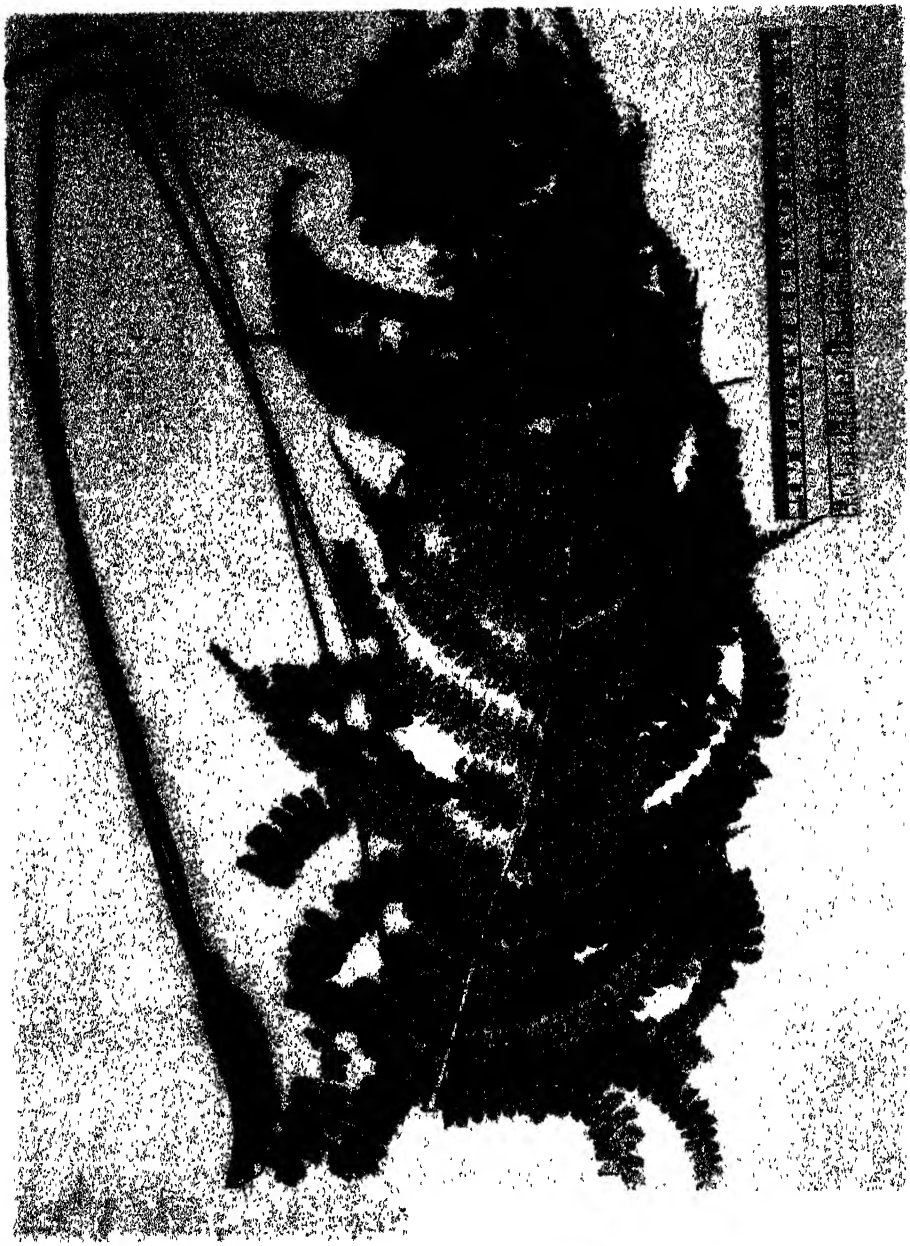


Dryopteris limaensis Copeland

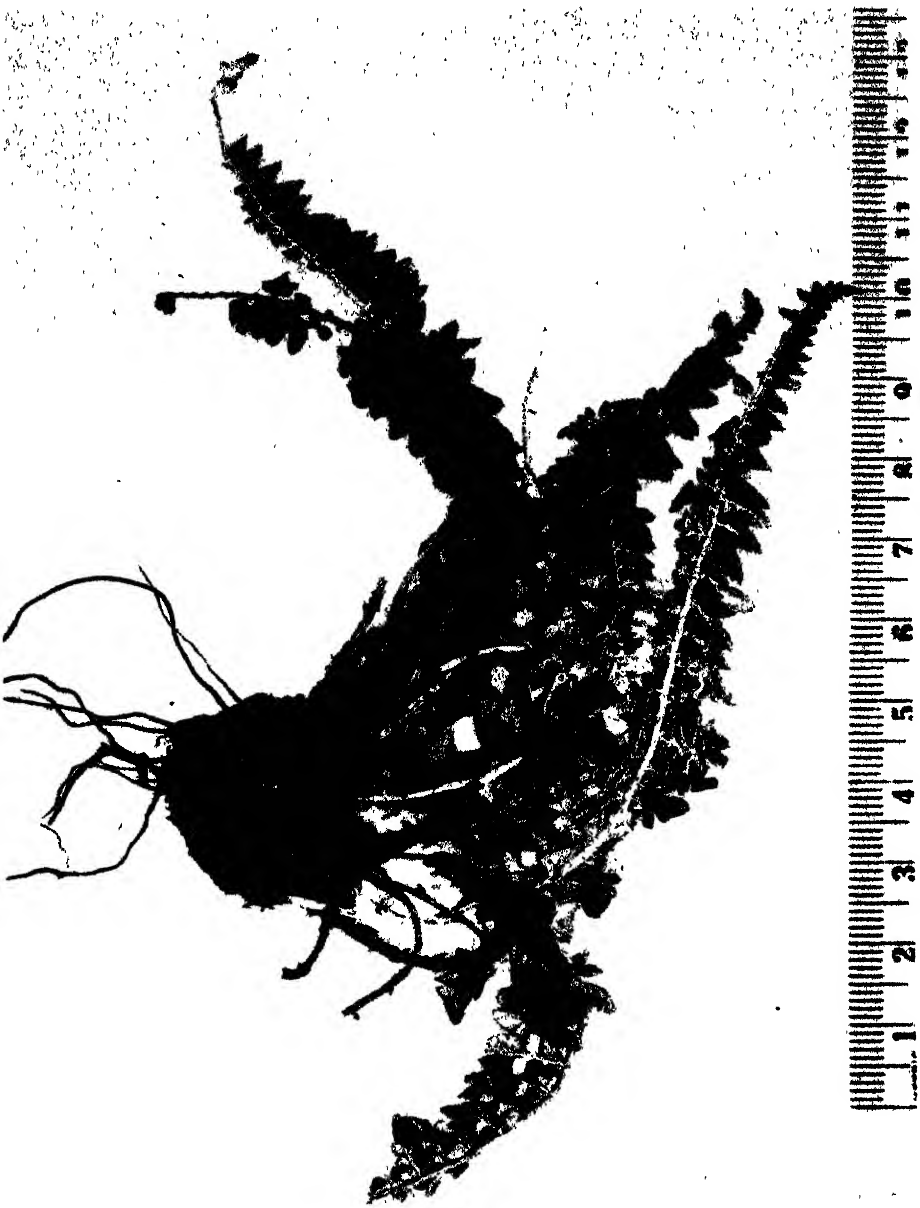


Dryopteris aequatorialis Copeland

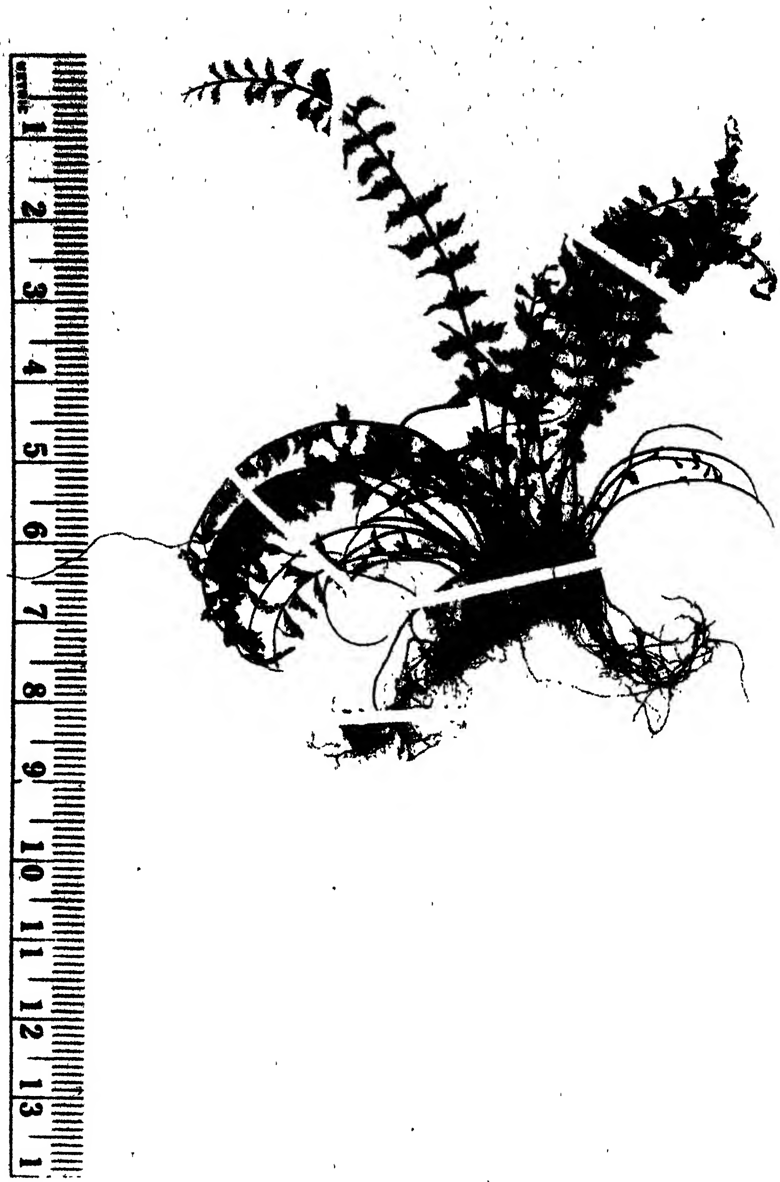
Dryopteris lomatosora Copeland



Polystichum Mexiae Copeland



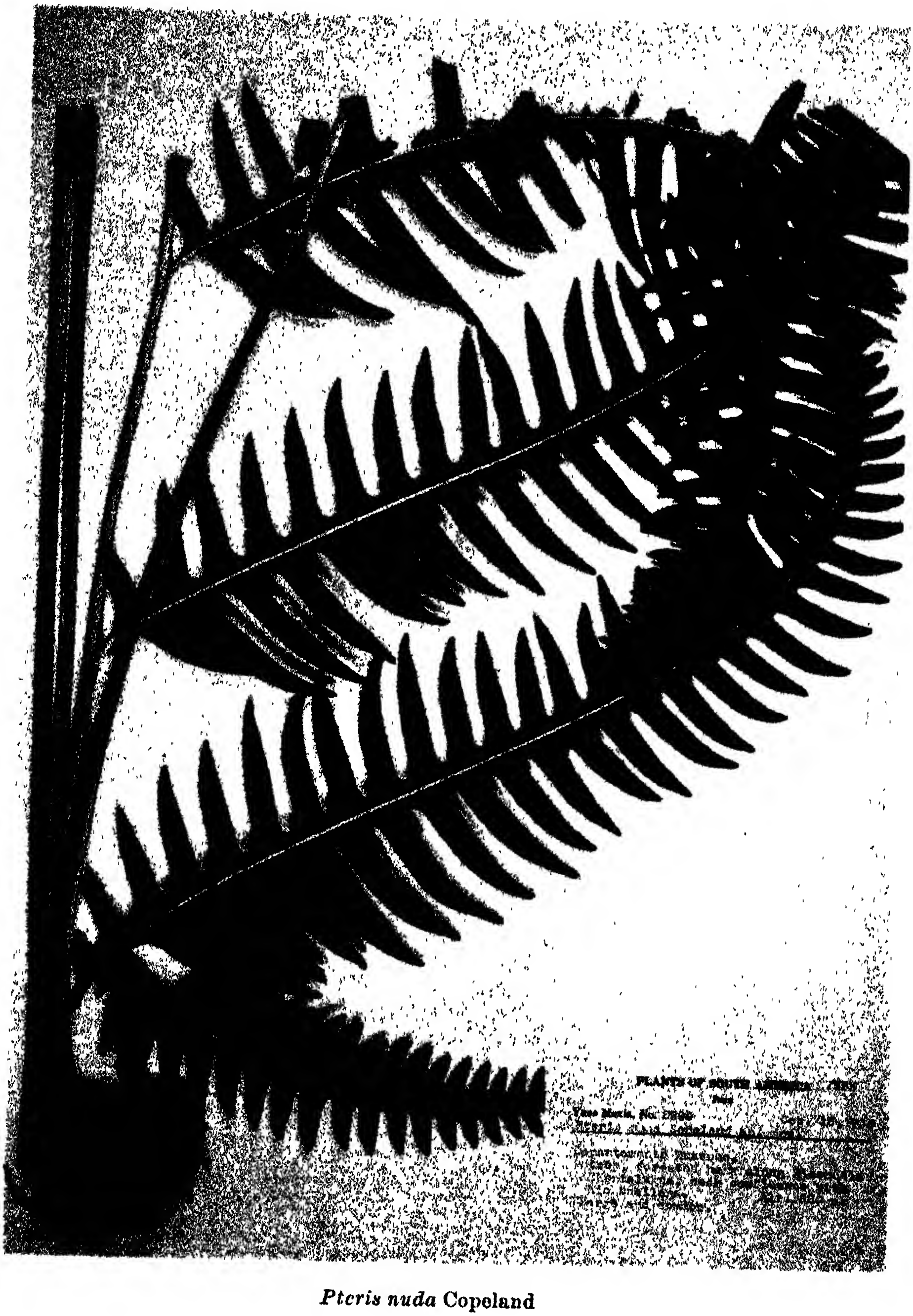
Polystichum pygmaeum Copeland



Asplenium Mexiae Copeland

Cheilanthes tripinnata Copeland

Pellaea peruviana Copeland

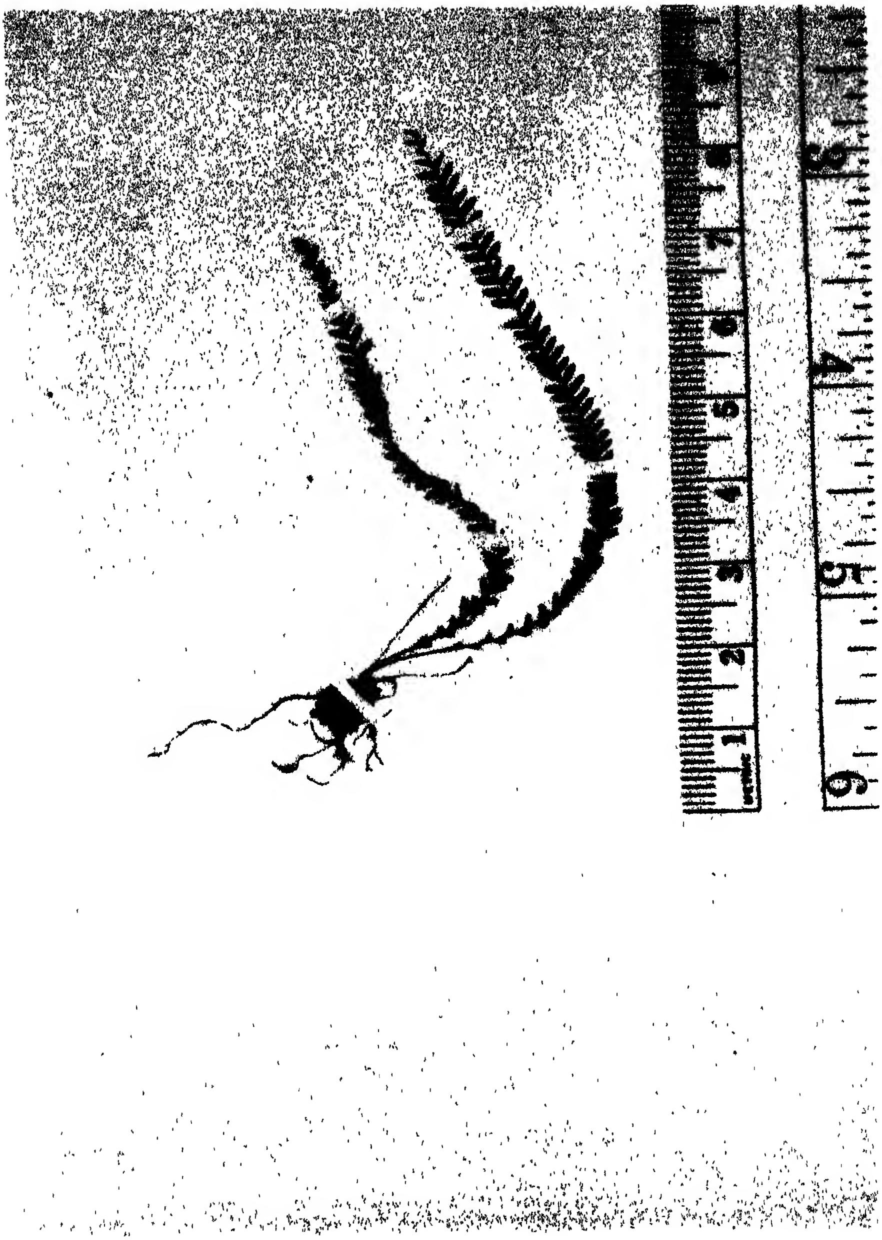


Pteris nuda Copeland

Adiantum Mexiae Copeland

Adiantum Kalbreyeri C. Christensen

Elaphoglossum craspedotum Copeland



Polypodium blepharidcum Copeland

Polypodium Ratibori Copeland

Polypodium appressum Copeland

THE GENUS NEMOPHILA NUTT.

BY

LINCOLN CONSTANCE

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THE GENUS NEMOPHILA NUTT.

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LINCOLN CONSTANCE

INTRODUCTION

Some explanation would appear to be needed for the publication of yet another revision of a genus which has been successively studied by Bentham (1834, pp. 274–276), Fischer and Meyer (1846, t. 8), Gray (1875, pp. 314–315), Eastwood (1901, pp. 137–160), Chandler (1902, pp. 194–215), Brand (1912, pp. 209–213; 1913, pp. 42–57), and Macbride (1919, pp. 29–32). A few additional papers have treated particular species or groups of species, and many brief, and more or less critical, accounts have appeared in local manuals and floras. In spite of this large body of information which has been amassed concerning *Nemophila,* all the revisions differ in important particulars. A great deal of material of the genus has been received into American herbaria during the third of a century since Eastwood and Chandler penned conflicting classifications of the group, and no monographer has attempted to examine the bulk of the specimens. The existence of these unworked collections and the increased opportunities for widespread field work have permitted the accumulation of data suggesting the need for a disposition of the species somewhat different from any of those hitherto proposed. The confusion in which *Nemophila* has remained in the herbaria examined suggests that none of the revisions has proved entirely satisfactory. The present paper has been undertaken with all of these considerations in mind. The opportunities for study have been unusually favorable. The genus has its greatest development in the California flora both as to frequency of individuals and number of species, most of which have been readily accessible in the field. Those specimens upon which Chandler based his work and many collections cited by Brand are in the herbarium of the University of California or among the collections of Dr. W. L. Jepson. Miss Alice Eastwood has generously made available the types of the species described by her, which are the property of the California Academy of Sciences.

A survey of the major revisions affords an index to the increased store of material and data available to each successive author and gives a clue to the taxonomic concepts employed by these writers. Thus, Bentham admitted 6 species for the genus, Fischer and Meyer, 8, and Gray, 9. Without attempting a revision of the previously described species, Eastwood, in several papers, published a total of 34 as new. Chandler recognized 14 species and 4 varieties, later adding 2 more varieties; Brand, 17 species, 4 subspecies, 26 varieties, 5 subvarieties, and 5 forms, and Macbride, 15 species and 10 varieties. The earliest authors had no opportunity for field study, and there was insufficient

dried material to bring all of the species to their attention and to make clear the diversity exhibited by some of them in their native habitats. This diversity was emphasized in a spectacular fashion by Eastwood, but certain of the older species were redescribed and specific rank was accorded to variations of very unequal importance.

The first relatively complete revision was that of Chandler, who correlated the Eastwoodian segregates with previously described entities and placed them with the species to which he thought they belonged. Brand followed Chandler's basic treatment, but reëlevated most of the species which Chandler had reduced to synonymy, placing them in subordinate categories of various grades. Thus was produced a large number of awkward polynomials, a procedure which has found little favor in this country. Macbride, also, adhered closely to Chandler's arrangement without attempting additional field work, but transposed the entire genus to *Viticella* Mitch. *Nemophila* has now been proposed for conservation over *Viticella,* inasmuch as it has been the only name in general use for this genus and has not been used for any other. *Viticella,* however, has been used for another genus, and probably the identity of the plants upon which Mitchell based the name will always remain debatable.

The revision outlined in the following pages is mainly based upon the excellent classification proposed by Chandler. The chief departure from traditional opinion is the removal of several species which have usually been placed in *Nemophila* to *Pholistoma* Lilja. The reasons influencing this step have been fully documented elsewhere (Constance, 1939, pp. 28–33) and need not be repeated here. Modifications have been made in Chandler's dispositions wherever extensive field work and more recent collections have indicated the necessity of altering the status of certain entities. Eleven species and 6 varieties, exclusive of the 2 species and 1 variety which have been transferred to *Pholistoma,* find a place in the present treatment.

The morphology of *Nemophila* has been dwelt upon at some length by Brand, and it is not my intention to duplicate his discussion. Those morphological considerations which have strongly influenced the arrangement of species, however, will be briefly presented.

Habit.—Most of the species, at least those whose individuals grow under the favorable influence of a sustained water supply, undergo a long-continued development, in the course of which they pass through a regular sequence of vegetative forms. The plants normally commence to flower and fruit almost as soon as they reach the surface of the ground. These earliest stages are usually very small, erect, and almost unbranched, with cotyledons still attached. Subsequently the stems elongate, branch freely, and become more or less decumbent, the cotyledons soon withering. In many species, the earliest leaves are all opposite and dissected, but those which develop on the rapidly lengthening branches may be alternate and less deeply cut or even entire. The flowers often become progressively smaller as the season advances, and their shape may change appreciably during the same period of time. Because

growth may be abruptly halted at any period by the exhaustion of available moisture, a particular growth stage may become "fixed." If water conditions are similar throughout a locality or region in a particular year, then the entire population of this area is likely to cease growth at about the same point. It is not surprising that many segregates have been described which are based in large part upon one or another of these normally transitory stages. This was extremely likely to occur in herbarium studies since adequate specimens showing the behavior of a species over a complete seasonal and geographical range were rarely available. Thus, *N. pustulata* is an early phase of *N. parviflora; N. exigua,* of *N. pedunculata; N. Menziesii* var. *minor,* of *N. Menziesii* var. *integrifolia; N. humilis,* of *N. spatulata;* and *N. petrophila,* of *N. breviflora.* Comparable series can be adduced for most of the species, even including *N. maculata,* whose variant stages have not been honored with special nomenclature.

Leaves.—Three fundamental types of leaf arrangement occur in the genus: (1) all opposite; (2) all alternate; and (3) the lower opposite and the upper alternate. These leaf positions are very useful in distinguishing natural entities but must be used with caution with respect to those plants which produce both opposite and alternate leaves. The growth of these plants may be arrested before any alternate leaves are produced, thus suggesting that their leaves are entirely opposite. Again, if the plants become especially diffuse, the opposite lower leaves may wither and drop off, leaving only the alternate. Thus, sprawling forms of *N. heterophylla* which have many alternate and shallow-toothed leaves were designated as distinct species, under the names of *N. decumbens, N. flaccida,* and *N. inaequalis.* It is customary to regard leaf form as an unstable feature upon which little weight can be placed for purposes of classification. In *Nemophila,* unorthodox as it may seem, each species and variety exhibits a basic type of leaf shape and division, which is subject to great variation but usually remains sufficiently constant to afford an easily utilizable means for rapid identification. Because these leaf forms are often difficult to describe clearly, the most characteristic of them, together with their principal variations, are figured in the accompanying plates. Stomatal measurements revealed no correlation of size of these structures with other specific lines, but a significant difference in the distribution of stomata was found. In all species except *N. maculata* (Brand, 1913, p. 7) and *N. spatulata,* stomata are borne only upon the lower side of the leaf, whereas in these two stomata occur upon both surfaces.

Auricles.—The presence of auricles on the calyx was first emphasized by Bentham (1834) and, in recent years, has become the major consideration for the generic delimitation of *Nemophila.* The usefulness of the auricles as a key character appears to have been the chief obstacle in the way of accepting Baillon's (1891, p. 397) mergence of *Ellisia* L. and *Nemophila* into *Ellisia.* It should be pointed out that too great reliance has often been placed upon the presence or absence of these structures. They may be either conspicuous

or entirely wanting in *Hydrophyllum* and *Pholistoma*. Furthermore, the auricles frequently become quite obsolete in *N. pulchella* and its varieties and are sporadically absent in other species of the genus.

Corolla scales.—Fischer and Meyer (1846) made the first attempt to classify *Nemophila* upon the basis of the form, size, and attachment of the corolla scales. The genus was divided into three sections, S. *Lepidophora,* S. *Pterogramme,* and S. *Trichogramme,* solely upon variations in this structure. That this division was thoroughly artificial is shown by the fact that *N. liniflora* and *N. insignis,* two color phases of *N. Menziesii* H. & A., were placed in different sections, and *Pholistoma auritum* was included in the same section with *N. heterophylla.* The structure of the squamae was reëlevated to a role of importance by Eastwood (1901), who used it, together with general habit, corolla form, and the shape of the cucullus of the seed, as a major criterion for delimiting species. Chandler (1902) endeavored to prove that the corolla scales were too variable upon a single plant or within a small colony to be of taxonomic worth, but later (Chandler 1907, p. 381) he used them as the chief argument for segregating two additional varieties of *Nemophila.* Recently, Munz and West (1935, p. 404) have combined corolla size with scale shape, attachment, and pubescence to achieve a realignment of the southern Californian variants of *N. Menziesii.* In my experience the corolla scales are decidedly less variable in a given locality, or even within a particular region, than Chandler supposed. However, within almost all the species there is a parallel trend in the direction of complete elimination of these appendages, and their state of structural development varies independently of other characters. If they are to afford taxonomic characters at all, it would seem that this character must be used as a criterion with extreme caution. Dr. Jepson notes that the scales sometimes completely close the corolla tube, presumably excluding moisture. The modifications of corolla scales, as revealed in a geographical series of a single species, *N. heterophylla,* are shown in figure F, 1–20.

Seeds.—The form and surface configuration of the seeds and the degree of degeneration of the cucullus (rather than its gross shape) have been given unusual weight in the present study. All of the species possess some trace of such a cucullus (now that the ecucullate species have been removed to constitute a natural group under *Pholistoma*), and the structure is lacking in all other genera of the tribe, so that its presence becomes a major generic distinction. Brand (1913) has speculated at some length on the significance of this cucullus, and it seems reasonable to agree with him that it may be a gradually disappearing remnant of an additional seed coat. The cucullus is reduced to a minute, persistent patch of colorless cells in *N. breviflora, N. microcalyx,* and *N. phacelioides;* it is reduced but deciduous in *N. Kirtleyi;* in all other species it is obvious and deciduous. Likewise, the pattern of the seed coat shows striking differences. In the four species just mentioned the seeds are pitted in regular rows, whereas in the remaining species the pits are irregu-

larly arranged, or else pits may be entirely absent. The seeds are never reticulate or alveolate as they are in the related genera, *Hydrophyllum, Ellisia,* and *Pholistoma.*

The geographical distribution of each species and variety is indicated on the accompanying maps. The assignment of certain species to a particular map is not to be construed as any indication of close relationship between them. The chief consideration has been to place as many species on the same map as possible without allowing them to overlap or to become unduly crowded. It will be observed that the greatest concentration of species is on the Pacific Coast, and particularly within the state of California; 4 species and 3 varieties are endemic to the state; 3 species and 2 varieties occur in California but extend their ranges beyond its borders either north or south or in both directions; 1 species and 1 variety are confined to the Great Basin but reach northeastern California. Only 3 species are not represented in California, 1 being confined to the Snake River drainage system and the other 2 restricted to the southeastern United States. Consequently, on the basis of present-day distribution alone, one would scarcely be tempted to look to the north of California for the point of origin for most of these species. The presence of 2 species near the northern rim of the Gulf of Mexico suggests that these have come into their present range from the south.

The relationship of the genera comprising the tribe Hydrophylleae of the Hydrophyllaceae has already been summarized (Constance 1939, pp. 28–33). No general pronouncements concerning phylogenetic relations within the genus *Nemophila* are included in the present paper. Such suggestions of affinity as have become apparent during the course of the study are noted in the accounts of the individual species.

ACKNOWLEDGMENTS

It is a pleasure to acknowledge the very substantial help which has been received from many quarters in the pursuance of the present study. Dr. Willis Linn Jepson has generously lent the valuable material contained in his personal herbarium and has made available the rich store of field data accumulated over a period of years in his extensive series of field notebooks. Miss Alice Eastwood and Mr. John Thomas Howell have extended every kindness and have opened for inspection the collections of the California Academy of Sciences, which are especially well supplied with specimens of Hydrophyllaceae. I am grateful to a number of persons who have donated valuable collections and data, including Mr. Milo S. Baker, Dr. Robert F. Hoover, Dr. Herbert L. Mason, Dr. Mildred E. Mathias, Mr. Don L. Peters, and Mr. Clarence R. Quick. Specimens of *Nemophila* were kindly lent from the personal herbaria of Mr. Milo S. Baker, Kenwood; Mr. J. H. Christ, Spokane; Mr. Ira W. Clokey, South Pasadena; Dr. R. J. Davis, Pocatello; Dr. Robert F. Hoover, Berkeley; Dr. Bassett Maguire, Logan; Mr. Frank W. Peirson, Altadena; and Mr. J. William Thompson, Seattle.

The curators of the following institutions (designated in text by initials as here given) have generously permitted me to borrow freely from the collections in their care:

BC	Provincial Museum of Natural History, Victoria
CA	California Academy of Sciences
CU	Cornell University
F	Field Museum of Natural History
G	Gray Herbarium, Harvard University
K	Royal Botanic Gardens, Kew
M	Missouri Botanical Garden
NY	New York Botanical Garden
OS	Oregon State College
P	Pomona College
PA	Academy of Natural Sciences of Philadelphia
RM	Rocky Mountain Herbarium, University of Wyoming
S	Dudley Herbarium, Stanford University
UC	University of California
UIS	University of Idaho, Southern Branch
UO	University of Oregon
US	United States National Herbarium
USF6	United States Forest Service Herbarium of Region 6
UW	University of Washington
VTM	Vegetation Type Map Herbarium, California Forest and Range Experiment Station
Wil	Willamette University
WS	State College of Washington

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The first set of my 1938 collections is deposited in the herbarium of the University of California. The duplicates of *Nemophila, Eucrypta,* and *Pholistoma* have been distributed to the herbaria listed above.

SYSTEMATIC TREATMENT

Nemophila Nutt.

Nemophila Nutt. ex Barton, Fl. N. Amer., 2:71. 1822 & Nutt. in Jour. Acad. Phila., 2:179. 1822, nom. gen. conserv. proposit.
Viticella Mitch., Diss. Brevis. Bot. and Zoöl., 42. 1769.

Delicate and often weak annual herbs. Stems slightly succulent and brittle, angled or winged, pubescent or glabrous, or armed with minute recurved prickles, at first simple but later diffusely branched. Cotyledons with an oblong to orbicular blade, truncate at base or tapering into a slender or winged petiole of equal or greater length, withered at anthesis or persistent. Leaves all opposite, all alternate, or the lower opposite and the upper alternate; the lower oblong to orbicular in outline, subcordate to cuneate at base, variously lobed or pinnately divided into lobes which are entire or again toothed or lobed, more or less pubescent on both surfaces or glabrate, stomatiferous on

both surfaces or stomatiferous below only; uppermost leaves like the lower but short petioled or reduced and less divided to entire. Petioles narrowly winged, slightly connate-clasping at base, hispid-ciliate. Flowers solitary in the axils or opposite the alternate leaves or the terminal flowers in a short, raceme-like cyme. Pedicels slender or stout, elongating and usually recurving or tortuous in fruit. Calyces campanulate, divided nearly to the base into 5 entire lobes, an auricle, which resembles a diminutive calyx lobe, in each sinus or auricles obsolete, both lobes and auricles pubescent or glabrate on both surfaces, hispid-ciliate. Corollas campanulate to rotate, predominantly white or blue, variously marked or plain, divided one-third to two-thirds into 5 entire or distally erose or pilose lobes, the whole corolla exceeding or rarely exceeded by the calyx. Corolla scales a pair at the base of each filament, adnate or partially free, entire, fimbriate or pubescent or reduced to hairy lines or obsolete. Stamens 5, included, the filaments about equalling or exceeding the corolla tube; anthers oblong or oval, cordate or sagittate at base. Pollen grains smooth, tricolpate. Style 1, shallowly to deeply bifid. Mature capsules ovoid or globose, 1-celled, loculicidally dehiscent by two valves, loosely hispid, enclosed by the calyx and surpassing it if the calyx is weakly accrescent, or exceeded by it if the calyx is strongly so. Ovules borne on the front of the two large parietal placentae. Seeds usually 1–20, more or less ovoid, corrugate-tuberculate or smooth, regularly or irregularly pitted or without evident pits, yellow, red, brown, or black. Cucullus present, shallow or papillaeform, conspicuous or reduced, deciduous or persistent. Type species: *N. phacelioides* Nutt. ex Barton.

Artificial Key to the Species

A Leaves all alternate; seeds pitted in rows; cucullus persistent and reduced; southeastern United States and Great Basin.

B Stems pubescent but not prickly; corolla exceeding calyx; southeastern United States.

C Corollas 1–3 cm. broad, blue or purplish; auricles prominent; terminal flowers often cymose; capsules equalling or exceeded by accrescent calyx 1. *N. phacelioides*

CC Corollas 0.5 cm. or less broad, white; auricles minute; flowers all solitary; capsules exceeding calyx....................................2. *N. microcalyx*

BB Stems glabrous but minutely prickly; corolla shorter than calyx; seed globose, solitary; Great Basin......................................3. *N. breviflora*

AA Leaves all opposite or the upper alternate; cucullus deciduous; Pacific Coast and Great Basin.

D Capsules exceeded by fruiting calyx; seeds pitted in rows; cucullus reduced; Snake River drainage...4. *N. Kirtleyi*

DD Capsules equalling or exceeding calyx; seeds irregularly pitted or without evident pits; cucullus conspicuous.

E Corollas 1 cm. or more broad (cf. nos. 7, 10, and 11 for rare exceptions); leaves all opposite.

F Seeds corrugate-tuberculate; lower surface of leaves paler and stomatiferous; corollas white or blue and variously marked but without distal purple blotches.

G Upper leaves like the lower, all deeply divided into 5–13 lobes.

H Corollas with blue periphery or prominently blue-venose and often black-punctate at center; stems more or less pubescent..6. *N. Menziesii*

HH Corollas white and conspicuously black-punctate nearly to periphery; stems glabrate ....6*a*. *N. Menziesii* var. *atomaria*

GG Upper leaves unlike the lower, shallowly few-lobed or nearly entire; corolla scales triangular, free at tip and hairy
6*b*. *N. Menziesii* var. *integrifolia*

FF Seeds smooth or pitted; both sides of leaves alike and stomatiferous; corollas white or venose but with a purple blotch at tip of each lobe. 8. *N. maculata*

EE Corollas less than 1 cm. broad.

I Corollas pelviform or campanulate; filaments about equalling corolla tube.

J Auricles ⅓ as long as sepals at least in fruit; corollas pelviform, white and usually marked with black, blue, or purple; plants of moist open places or in light shade.

K Leaves oblong or oval, deeply divided, truncate or weakly cuneate at base, paler and stomatiferous below; ubiquitous but chiefly at low altitudes ....5. *N. pedunculata*

KK Leaves spatulate, shallowly lobed or toothed, strongly cuneate, both surfaces alike and stomatiferous; Sierra Nevada, etc., at middle and high altitudes ....7. *N. spatulata*

JJ Auricles less than ⅓ sepals even in fruit; corollas pelviform or campanulate, white or bluish but unmarked; chiefly plants of shaded habitats.

L Basal leaves divided into 5–7 similar, distinct, orbicular, petiolulate divisions, sinuses broad; corollas pelviform; style usually 2–3 mm. long and conspicuously exserted from calyx.............10. *N. heterophylla*

LL Basal leaves incised or shallowly lobed, some divisions dissimilar, confluent or not petiolulate; corollas campanulate; style 1.5 mm. or less long, not prominently exserted; seeds yellow or orange.

M Leaves deeply incised, lobes usually acute; coastal...9. *N. parviflora*

MM Leaves shallowly lobed, lobes obtuse; inland.

N Leaves glabrate or hispid, cuneate at base, lobes triangular-ovate; Great Basin...................9*a*. *N. parviflora* var. *Austinae*

NN Leaves villous, obtuse or subcordate at base, lobes rounded; southern Sierra Nevada.............9*b*. *N. parviflora* var. *quercifolia*

II Corollas rotate or nearly so; filaments exceeding corolla tube.

O Auricles conspicuous; seeds 4–10, corrugate-tuberculate; corolla scales conspicuous, free at tip; southern and Baja California
6*b*. *N. Menziesii* var. *integrifolia*

OO Auricles minute or obsolete; seeds 1–4, smooth or obscurely roughened; central California.

P Corollas blue, 7–12 mm. broad, at least twice as long as calyx; style 2–3 mm. long, conspicuously exserted from calyx.......11. *N. pulchella*

PP Corollas white, 3–6 mm. broad, equalling or barely surpassing calyx; style 0.5–1.5 mm. long, included.

Q Basal leaves distant, upper leaves alternate; style 1–1.5 mm. long; seeds solitary.....................11*a*. *N. pulchella* var. *gracilis*

QQ Basal leaves crowded into a rosette, upper leaves usually opposite; style less than 1 mm. long; seeds 2–4. 11*b*. *N. pulchella* var. *fremontii*

1. Nemophila phacelioides Nutt. ex Barton

N. phacelioides Nutt. ex Barton, Fl. N. Amer., 2:71. 1822 & Nutt. in Jour. Acad. Phila., 2:179. 1822.

N. Nuttallii Colla, Hort. Rip. App., 1:135, t. 5. 1825.

N. nemorosa Reuben-Heynes ex Steud., Nom. Bot., ed. 2, 2:189. 1841, as synonym.

N. hirsuta Buckley, Proc. Acad. Phila., 13:462. 1862.

N. pilosa Buckley, *op. cit.*, p. 463.

Viticella phacelioides Macbride, Contr. Gray Herb., 59:30. 1919.

Stems rather stout, 2–6 dm. long, hirsute or glabrate; blades of the cotyledons oval, 1.5 cm. long, 1 cm. broad, exceeded by the petiole, deciduous; leaves alternate, the lower oblong, obtuse, cordate at base, 6–8 cm. long, 2.5–5 cm. broad, pinnately divided into 9–11 ovate divisions, obtuse or acute, entire or 2–5-toothed, the terminal confluent, petioles equalling or shorter than blades, uppermost leaves smaller, short petioled, ovate-deltoid or orbicular, all more or less hirsute or hispid; flowers solitary on long pedicels opposite the leaves or the terminal in a cyme; calyx broadly companulate, lobes oblong- to ovate-lanceolate, 6–7 mm. long, 2–3 mm. broad, auricles erect or spreading, 1–3 mm. long; corolla pelviform or nearly rotate, blue or purplish with paler center, 1.5–3 cm. broad, the obovate lobes twice length of tube, somewhat erose; corolla scales broad, often partly free and fimbriate; filaments about equalling tube, anthers oblong, 2–3 mm. long; style 3–5 mm. long, cleft ½; mature capsule 5–9 mm. in diameter, exceeded or equalled by the accrescent calyx; seeds usually 4, nearly globose, red-brown, regularly and deeply pitted in rows, 4–5 mm. in diameter; cucullus reduced, persistent.

Type locality.—"In the shady woods of Cedar prairie, ten miles from Fort Smith, and from thence in similar situations to the sources of the Pottoe" (probably Sebastian County), Arkansas, *Nuttall.*

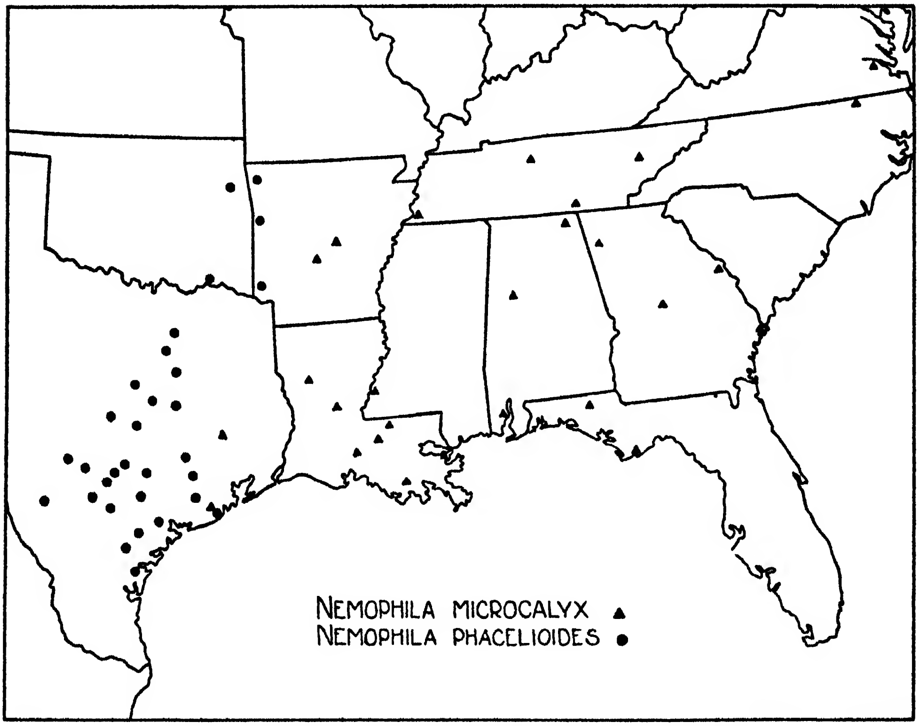
Range.—Southeastern Texas and adjacent Arkansas and Oklahoma; in moist shade.

Specimens examined.—Arkansas. Locality uncertain: "Arkansas," *Nuttall* (G, NY, PA), (1863), *Durand* (F); "N. W. Ark." (1883), *Harvey* (F, US); "Red River," *Nuttall* (PA). Washington Co.; Fayetteville (1923), *Buckholz* (NY); Johnson, *Haas* 1660 (US); Wheeler, *E. J. Palmer* 23,266 (M), 27,009 (M). Sebastian Co.: "Arkansas near Fort Smith or Belle Point," *Nuttall* (K: isotype of *N. phacelioides*). Sevier Co.: DeQueen–Buzzard Roost, *Brinkley* 53 (F).

Oklahoma. Locality uncertain: "on the False Washita, between Fort Cobb and Fort Arbuckle," *E. Palmer* 195 (NY, US). Cherokee Co.; South Fork of Illinois, *Engelmann* 157 (M). Choctaw Co.: Fort Towson, *Leavenworth* (NY, PA).

Texas. Locality uncertain: "Brazos Bottom," *Lindheimer* 102 (M); "Comele Spring" (1880), *C. Mohr* (US); "Texas," *Wright* (G), *Drummond* 300 (G, K, NY); "Western Texas" (1860), *Buckley* (PA: type of *N. hirsuta,* G). Dallas Co.: Dallas, *Stephenson* 203 (US). Ellis Co.: Midlothian, etc., *Reverchon* 1333 (F, M, US). Navarro Co.: Dawson–Blooming Grove (1903), *Reverchon* (M). Bosque Co.: "on the Bosque," *Reverchon* 1333 (F, M, US). Limestone Co.: *Poor* 53 (US). McLennan Co.: Waco (1888), *Trimble* (S), (1905), *Pace* (M). Bell Co.: Cowhouse Creek, *Wolff* 2879 (US). Lampasas Co.: "on the Lampasas," *Reverchon* 1333 (NY, US). Washington Co.: *Hobart* (G).

Travis Co.: Austin (1860), *Buckley* (PA: type of *N. pilosa*), *E. Hall* 471 (F, G, K, M, NY, P, US), *Young* 105 (M, NY, P), *McKelvey* 1736 (G, P). Bastrop Co.: Smithville (1903), *Pilsbry* (PA). Hays Co.: San Marcos, *E. J. Palmer* 13,314 (M). Comal Co.: New Braunfels, *Lindheimer* 666 (F, G, K, M, NY, UC, US), 1012 (F, M, NY, PA, UC, US). Kendall Co.: Edge Falls (1938), *H. B. Parks* (UC). Kerr Co.: Kerrville (1907), *Milligan* (US). Uvalde Co.: Con Can, *E. J. Palmer* 11,547 (M, RM, UC, US). Bexar Co.: Medina River, *Sister Mary Clare* 510 (CA, P, RM, S); San Antonio, *Canby* 165 (G, PA, US), *Clemens & Clemens* 313 (CA, M, P). Wilson Co.: Sutherland



Map 1. Distribution of *N. phacelioides* and *N. microcalyx.*

Springs, *M. E. Jones* 29,205 (CU, M, P, UC). Gonzales Co.: *Bogusch* 964 (US). Austin Co.: Industry (1891), *Wurzlow* (F); Mill Creek, *Lindheimer* 103 (M). Wharton Co.: Wharton, *E. J. Palmer* 4899 (CU, M, P). Brazoria Co.: Brazoria, *E. J. Palmer* 5124 (CU, F, M, P, US). Victoria Co.: Victoria, *E. J. Palmer* 9095 (M, S); Guadalupe, *Lindheimer* 309 (M). Goliad Co.: Goliad, *C. B. Williams* 55 (PA); "Valley of the St. Antonio" (1900), *Eggert* (G, M). Bee Co.: Tuleta (1925), *Wright & Wright* (CU). Nueces Co.: Agua Dulce, *Lindheimer* 293 (G, M).

Few persons knowing *Nemophila* only from its Pacific Coast species would recognize *N. phacelioides* as a member of the genus, at first glance, but would be apt to mistake it for a *Hydrophyllum,* which it closely resembles in general aspect. The seeds, however, are cucullate and pitted, and the calyx is accrescent, characters which align it with the present genus. It is the only

species of *Nemophila* in which the terminal flowers are cymose, these being solitary in all its relatives. This condition of the inflorescence suggests that found in *Ellisia* and *Pholistoma*, but other characters preclude such a relationship.

The alternate leaves, regularly pitted seeds, and reduced, persistent cucullus resemble those of *N. microcalyx* and *N. breviflora*, and the strongly enlarging calyx suggests *N. breviflora* and *N. Kirtleyi*. The large corollas, however, bear a resemblance to those of *N. Kirtleyi*, *N. maculata*, and *N. Menziesii*, but other characters are conflicting. Whatever its affinities may be, there can be little doubt that *N. phacelioides* is quite distinct from any of its supposed relatives by virtue of the combination of its morphological characters and its geographical distribution.

2. Nemophila microcalyx (Nutt.) Fisch. & Mey

Ellisia microcalyx Nutt., Trans. Amer. Philos. Soc., N. S., 5:191. 1837.
Hydrophyllum pusillum Muhl. ex Nutt., *op. cit.*, p. 191, as a synonym.
Nemophila microcalyx Fisch. & Mey., Sert. Petrop., t. 8. 1846.
N. evanescens Darby, Bot. South. States, 444. 1866.
Viticella microcalyx Nieuwland, Amer. Midl. Nat., 3:158. 1913.

Stems weak, 0.5–4 dm. long, sparsely hispid; blades of the cotyledons oval, 9–13 mm. long, 6–7 mm. broad, truncate, exceeded by the petiole, deciduous; leaves alternate, the lower ovate or orbicular, obtuse, subcordate at base, 1–3.5 cm. long, 1–2.5 cm. broad, pinnately divided into 3–5 obovate to cuneate, asymmetrical divisions (the two lower often petiolulate), remote and obtuse, the larger with 1–3 shallow teeth distally and sometimes 1 or more proximally, petioles exceeding blades, uppermost leaves often deltoid-orbicular, short petioled and with fewer and less remote divisions, all loosely appressed-hispid; flowers solitary on short pedicels opposite the leaves; calyx broadly campanulate, lobes narrowly lanceolate, acute, 1–1.5 mm. long, 0.5 mm. broad, auricles minute, reflexed, 0.1–0.3 mm. long; corolla campanulate, white or bluish, 2–4 mm. broad; the ovate lobes shorter than or equalling tube, often erose, whole corolla exceeding calyx by ½; corolla scales minute and entire or obsolete; filaments shorter than tube, inserted above base, anthers oval, about 0.3 mm. long; style 0.7–0.9 mm. long, cleft about ½; mature capsule about 3–4 mm. in diameter, greatly exceeding weakly accrescent calyx; seeds 1–3, ovoid, 3 mm. in diameter, light brown, regularly pitted in rows; cucullus reduced, persistent.

Type locality.—"In Arkansas, Alabama, etc.," *Nuttall.*

Range.—Southeastern Texas and adjacent Arkansas to Florida, Tennessee, and Virginia; in damp woods.

Specimens examined.—VIRGINIA. Locality uncertain: "E. Virginia" 1877, *Wibbe* (PA). Surry Co.: Claremont Wharf, *Fernald & Long* 7954 (G, M, NY).

NORTH CAROLINA. Halifax Co.: Weldon (1897), *Small* (NY).

TENNESSEE. Knox Co.: Knoxville (1890–8), *A. Ruth* (F, G, M, NY, PA, RM, S). Davidson Co.: Nashville (1875–80), *Gattinger* (CU, F, G, M, NY, OS, PA, S, UC). Marion Co.: Battle Creek, *Cain & Sharp* 4418 (NY). Shelby Co.: Memphis (1846), *Fendler* (M).

GEORGIA. Locality uncertain: "Georgia," *Darby* (G: isotype of *N. evanes-*

cens); "Northern Georgia" (1864), *J. T. Stewart* (F). Richmond Co.: Augusta, *Olney & Metcalf* 263 (G), *Cuthbert* 465 (NY). Bibb Co.: Macon, *J. M. Greene* (PA). Floyd Co.: Rome, *Chapman* (US). Chatham Co.: Savannah (1838), *DeWette* (NY).

FLORIDA. Locality uncertain: "Chattahoucie," *Chapman* (NY); "Florida," *Chapman* (G, K, NY, S, US). Franklin Co.: Apalachicola, *Chapman* (NY).

ALABAMA. Locality uncertain: "Alabama" (1841), *Buckley* (M), (1854)

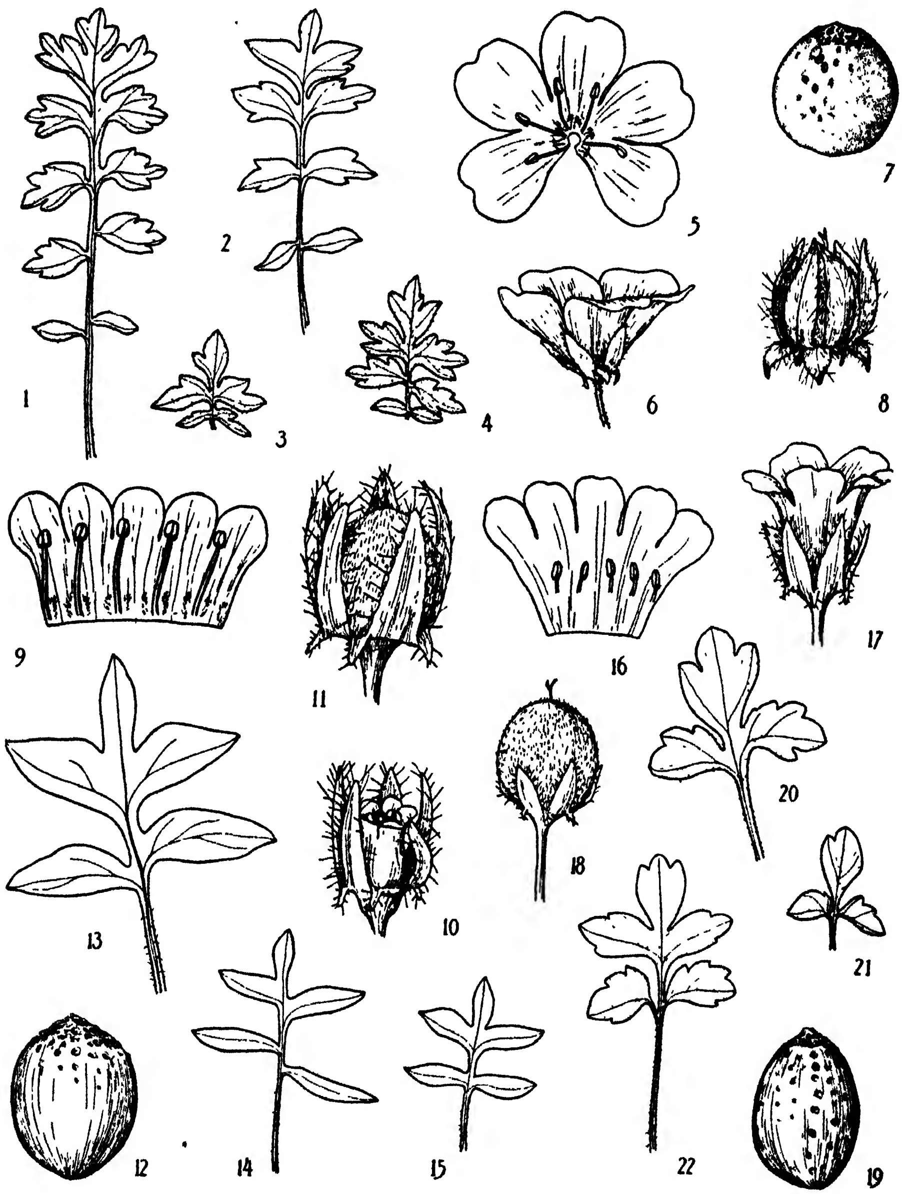


Fig. A. *N. phacelioides.* 1–4, leaves × ½; 5–6, corolla × 1; 7, seed × 5; 8, fruit × 2. *N. breviflora.* 9–10, corolla, no. 2332, × 8 and × 5; 11, fruit × 4; 12, seed × 7½; 13–15, leaves × 1. *N. microcalyx.* 16–17, corolla × 6; 18, fruit × 4; 19, seed × 7½; 20–22, leaves × 1.

C. W. Short (G). Jackson Co.: Stevenson, *Svenson* 7699 (PA, UC). Tuscaloosa Co.: Tuscaloosa (1892), *L. F. Ward* (US). Mobile Co.: Mobile (1860), *Mohr* (US).

MISSISSIPPI. Adams Co.: Natchez (1845), *C. W. Short* (M, PA).

LOUISIANA. Locality uncertain: "Feliciana," *Carpenter* (G, US); "Louisiana," *Carpenter* (M, PA, US). Rapides Co.: Alexandria, *Hale* (P). East Feliciana Co.: Jackson, *Ingalls* (NY). Saint Martin Co.: Saint Martinville (1888–93), *Langlois* (UC, US). East Baton Rouge Co.: Baton Rouge (1874), *Poor* (F). Orleans Co.: New Orleans, *Drummond* 232 (G), 233 (G, K), *Canby* 164 (US). Terrebonne Co.: Houma, *Small* 970 (NY). Natchitoches Co.: Grand Encore, *E. J. Palmer* 7049 (CA, M, PA, US); Natchitoches, *E. J. Palmer* 7232 (CA, M, PA, US).

ARKANSAS. Locality uncertain: "Arkansas," *Nuttall* (K, NY, PA: isotypes of *Ellisia microcalyx*), *Pitcher* (NY, PA). Pulaski Co.: Little Rock (1837), *Engelmann* (M, PA), (1885–86), *Hasse* (F, NY, PA, UC, UO, US). Hot Springs Co.: Cove Creek, *E. J. Palmer* 29,707 (M).

TEXAS. Locality uncertain: "Texas," *Drummond* 301 (G, K, US), *Wright* (G). Walker Co.: Riverside, *E. J. Palmer* 13,174 (M, US). Brazoria Co.: Columbia, *Bush* 447 (G, M, NY, US), *E. J. Palmer* 5056 (CU, M, P, US).

This distinct and well characterized species is far removed geographically from anything which might be confused with it. Because of the tendency of earlier botanists, however, to merge all species with small flowers under *N. parviflora*, it was at one time confounded with that very different species. The regular pitting and reduced and persistent cucullus of the seeds and the alternate leaves relate *N. microcalyx* to *N. phacelioides* and *N. breviflora*. The fact that the calyx scarcely enlarges in fruit clearly sets it apart from both. The small and always solitary white flowers easily distinguish it from *N. phacelioides*, which is nearest it in distribution. There is a suggestion of an affinity with *N. parviflora*, *N. heterophylla*, and *N. pulchella* of the Pacific Coast, but the resemblances are largely superficial, and there is probably no very close relationship with any of these species.

The species has been rather rarely collected, and still fewer of the specimens which have been made bear any exact ecological data. Apparently, however, it is a shade plant of moist situations, chiefly in alluvial soil.

3. **Nemophila breviflora** Gray

N. breviflora Gray, Proc. Amer. Acad., 10:315. 1875.

Viticella breviflora Macbride, Contr. Gray Herb., 59:32. 1919.

N. petrophila L. Williams, Ann. Mo. Bot. Gard., 23:453. 1936.

Stems weak, 0.5–2 dm. long, sharply angled, armed with minute reflexed prickles, otherwise glabrous; blades of the cotyledons oblong or oval, 0.7–2 cm. long, 2–5 mm. broad, tapering into a slender petiole of equal length, persistent; leaves alternate, the lower ovate-deltoid, obtuse, subcordate at base, 0.7–3 cm. long, 1.5–4 cm. broad, pinnately divided into 3–6 oblong-lanceolate, somewhat falcate and remote divisions, acute, entire or the larger with a single tooth, petioles about equalling blades, uppermost leaves short petioled, all sparsely hispid, venose and somewhat glaucous below; flowers solitary on very short pedicels; calyx broadly campanulate, lobes linear-lanceolate, 3 mm. long, 1–2 mm. broad, auricles reflexed, 1.5 mm. long; corolla narrowly cam-

panulate, white or purplish, 1.5–3 mm. broad, oval divisions distinctly shorter than tube, often emarginate and with a few hairs at apex, whole corolla surpassed by calyx; corolla scales cuneate or linear, free edge fimbriate, or reduced to hairy lines; filaments shorter than tube, anthers oval, 0.2–0.3 mm. long; style 0.5–1 mm. long, cleft only at apex; mature capsule 3–5 mm. in diameter, exceeded by the strongly accrescent calyx; seed usually 1, globose, 2–4 mm. in diameter, brick-red, smooth but regularly and deeply pitted in rows; cucullus reduced, persistent.

Type locality.—"In Parley's Park," Uintah Mountains (Salt Lake County), Utah, *Watson.*

Range.—Great Basin, from Colorado and Montana to Nevada, northeastern California, Washington, and southern British Columbia; Arid Transition and Canadian life zones.

Specimens examined.—COLORADO. Montrose Co.: Taboguache Basin, *Payson* 464 (G, RM). Routt Co.: Steamboat Springs (1891), *Eastwood* (NY).

WYOMING. Sheridan Co.: Tongue River, *Tweedy* 111 (NY). Sublette Co.: Big Piney, *Payson & Payson* 2616 (F, G, M, P, PA, RM, UC, US). Lincoln Co.: Alpine, *Payson & Armstrong* 3398 (CU, G, M, P, PA, RM). Teton Co.: Bradley Creek, *L. Williams* 1127 (M, OS, RM); Double Diamond Ranch, *L. Williams* 2172 (UC, US, WS: isotypes of *N. petrophila*), 3005 (G, M, NY, Thompson, WS); Grand Teton National Park, *L. Williams* 747 (G, M, NY, RM); Sensenbach's Ranch, *L. Williams* 1094 (M, OS, RM, S, Wil); Jackson's Hole (1860), *Hayden* (M). Yellowstone National Park: Glen Creek, *Nelson & Nelson* 5566 (CU, G, M, NY, P, RM, US); Mountain Hot Springs, *Tweedy* 405 (G); Soda Butte Creek, *Tweedy* 405 (US).

MONTANA. Flathead Co.: Holzinger's Basin, *Holzinger & Blake* 45 (US). Glacier Co.: Midvale, *Umbach* 124 (F, NY, RM, S, US). Missoula Co.: Miller Creek, *C. L. Hitchcock* 1764 (CA, P, RM, S). Cascade Co.: Upper Sand Coulee, *R. S. Williams* 170 (M). Madison Co.: Cedar Mountains, *Rydberg & Bessey* 4859 (NY). Gallatin Co.: Bozeman, *Blankinship* 536 (F, M, PA), 536*a* (P, RM, S, UC); Bridger Mountains, *Rydberg & Bessey* 4860 (F, G, NY, PA, RM, US), (1905), *W. W. Jones* (CA, M, P, RM, S, UC, US). Park Co.: Electric Peak, *E. C. S.* 147 (UC).

IDAHO. Locality uncertain: "alpine ravines of the Kooskooskee River," *Geyer* 645 (K). Kootenai Co.: Coeur d'Alene, *S. O. Johnson* 19 (RM); Santianne Creek, *Leiberg* 1062 (F, G, NY, P, RM, S, UC, UO, US). Latah Co.: Mount Moscow, *Piper* 1880 (F, G, NY, RM, US, UW, WS); Thatuna Hills, *Dillon & Dillon* 572 (WS). Nez Perce Co.: Craig Mountains, *Henderson* 2748 (CU, G, US). Idaho Co.: Papoose Creek, *Constance* 1864 (Thompson, UC, US). Adams Co.: Starkey, *Christ* 9201 (UC). Lemhi Co.: Salmon, *Payson & Payson* 1892 (CA, G, M, NY, RM). Washington Co.: Cuddy Mountains (1899), *M. E. Jones* (P); Deer Lake, *M. E. Jones* 6463 (M, P, US). Boise Co.: Arrow Rock Dam, *R. J. Davis* 77–36 (UIS). Camas Co.: Corral, *Macbride & Payson* 2934 (CA, G, M, NY, P, RM, S, UC, US). Blaine Co.: Ketchum, *Nelson & Macbride* 1214 (G, RM). Clark Co.: Spencer, *Rust* 688 (Christ, US). Fremont Co.: Warm River, *R. J. Davis* 3–35 (UIS). Bingham Co.: Mill Creek (1935), *R. J. Davis* (UIS). Bannock Co.: McCammon, *R. J. Davis* 838 (UC). Caribou Co.: Grays Lake, *R. J. Davis* 844 (UC). Franklin Co.: Preston, *Muenscher & Maguire* 2408 (CU, G, P, UC). Bear Lake Co.: Meadow Camp Ranger Station, *R. J. Davis* 384 (UC).

UTAH. Cache Co.: Logan Canyon, *Maguire & Gerber* 3686 (CU, G, RM, UC), 3687 (CU, M, RM, UC), *Muenscher & Maguire* 2407 (CU, M, UC).

Weber Co.: Ogden (1872), *J. M. Coulter* (PA). Wasatch Co.: Horse Creek, *Graham* 9265 (CA, F, G). Salt Lake Co.: Parley's Park, *Watson* 869 (G: type of *N. breviflora*, NY); East Bountiful (1908), *Clemens* (F, G, S); City Creek Cañon, *M. E. Jones* 1738 (F, NY, P, PA, S, UC, US). Utah Co.: Springville Canyon, *V. Livingston* 7113 (RM). San Pete Co.: Mammoth Ranger Station, *Eggleston* 10,170 (US).

NEVADA. Elko Co.: Cave Creek, *Mason* 4755 (UC), 4784 (UC); Jarbidge, *Nelson & Macbride* 2230 (G, M, NY, P, RM, US, UW).

CALIFORNIA. Modoc Co.: Thombs Creek, *Constance* 2332; Twelve Mile Creek (1907), *Manning* (UC).

OREGON. Harney Co.: Devine Ranch, *Leiberg* 2498 (CA, F, G, NY, P, UC, UO, US); Wild Horse Creek, *Peck* 14,023 (F, S, Thompson, Wil). Lake Co.: Crane Mountain, *Peck* 15,594 (NY, S, Wil). Crook Co.: Ochoco Forest, *Peck* 15,979 (NY, PA, Thompson, Wil), 17,050 (NY, Wil); Ochoco Mountains, *Henderson* 14,450 (UO). Grant Co.: Blue Mountains (1885), *T. Howell* (F, PA, UO, US, WS-part); Dixie Mountain, *Henderson* 5361 (CA, G-part, S, UO); Strawberry Butte, *Coville* 537 (US). Baker Co.: Baker City (1902), *M. E. Jones* (P). Union Co.: Union, *Cusick* 29 (G, UO); "Eastern Oregon," *Cusick* 2149 (CU, F, G, M, RM, UC, UO, US, WS). Wallowa Co.: Imnaha-Snake Divide, *Peck* 17,567 (NY, S, Wil).

WASHINGTON. Asotin Co.: Big Butte, *St. John & Palmer* 9589 (WS). Garfield Co.: Willow Spring, *D. L. Peters* 387 (UC, WS). Columbia Co.: Wildcat Springs, *St. John & Smith* 8313 (WS). Walla Walla Co.: Blue Mountains (1896), *Piper* (WS). Klickitat Co.: Falcon Valley, *Suksdorf* 173 (F, G, M, US, WS) and (1883) (F, NY, PA, S, UC). Kittitas Co.: Table Mountain, *Thompson* 9278 (CA, M, NY, P, S, Thompson, UC, US). Yakima Co.: Clemens Mountain (1892), *Henderson* (UO, UW, WS); Yakima Region, *T. S. Brandegee* 464 (PA, UC); Chelan Co.: Cashmere, *Thompson* 5975 (G, NY, OS, PA, S, Thompson, US). Spokane Co.: Mica Peak, *Suksdorf* 8827 (CA, WS). Okanogan Co.: Muckamuck Lookout, *R. Bigelow* 58 (M, Thompson); Oroville (1911), *M. E. Jones* (P).

BRITISH COLUMBIA. Lake Bootahnie, *Thompson & Thompson* 125 (Thompson, UC); Sophie Mountains, *Macoun* 66,614 (CA, CU, F, G, M, NY, P, WS).

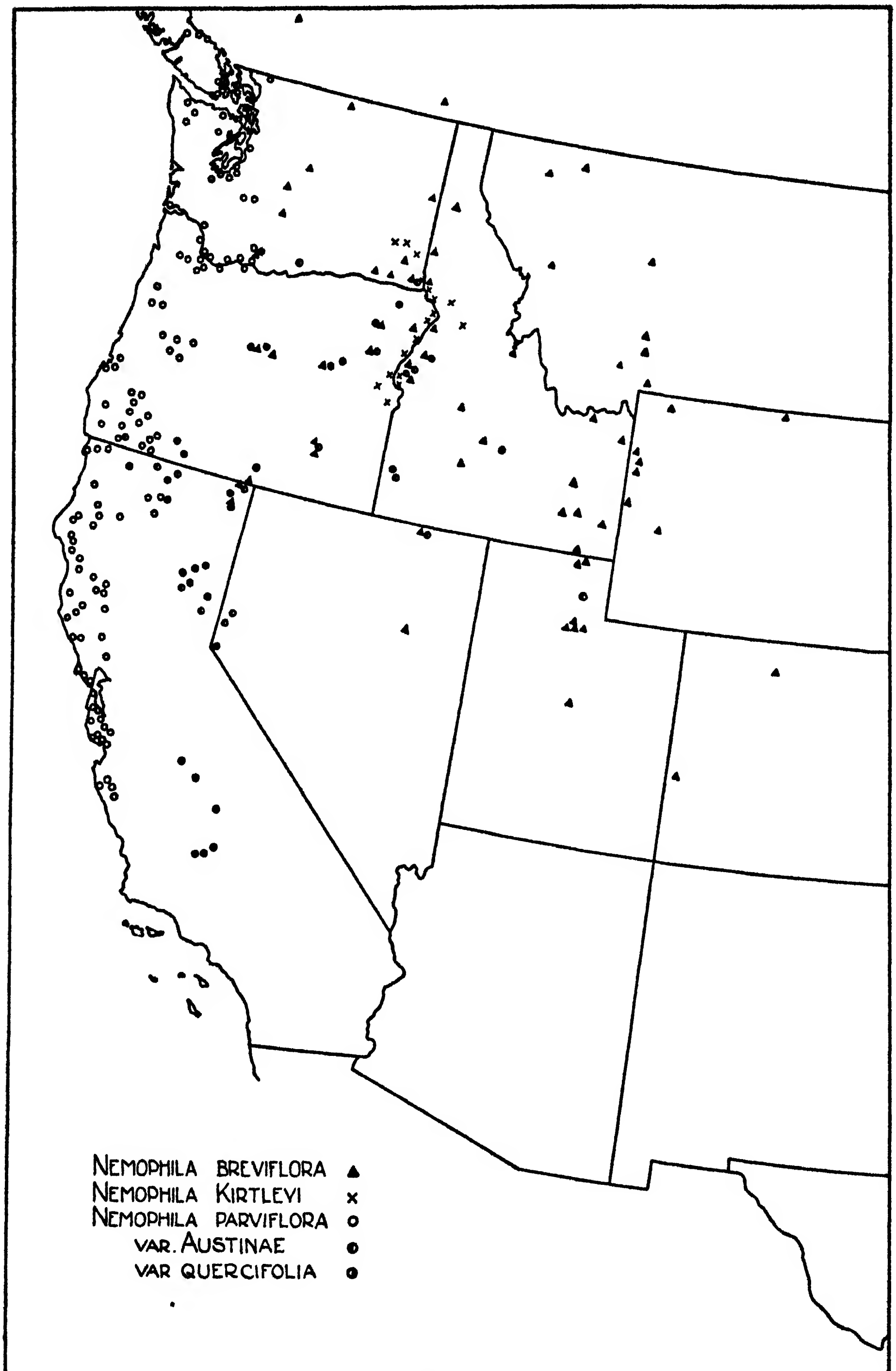
This is the only species which possesses a typically Great Basin distribution. The habit, the strongly accrescent calyx, and the narrowly campanulate, short-lobed corolla exceeded by the calyx, suggest an affinity with *Ellisia Nyctelea*. The prickles of the stem are found elsewhere only in *Pholistoma*. The regular pitting of the seed and the reduced cucullus are found also in *N. phacelioides*, *N. microcalyx*, and *N. Kirtleyi*. Except for an apparent kinship with *N. Kirtleyi*, *N. breviflora* appears to have no very close allies in the genus.

Earlier authors confused *N. breviflora* with *N. parviflora* because of its small, short corollas. No morphological differences have been found between *N. petrophila* and *N. breviflora*, so the former is placed in synonymy.

4. Nemophila Kirtleyi Henderson

N. Kirtleyi Henderson, Bull. Torrey Club, 27:350. 1900.
Viticella Kirtleyi Macbride, Contr. Gray Herb., 59:31. 1919.

Stems 2–20 cm. long, sparsely hispid; blades of the cotyledons oval, 0.5–2 cm. long, 0.4–1.2 cm. broad, tapering into a petiole of equal length, often



Map 2. Distribution of *N. breviflora*, *N. Kirtleyi*, *N. parviflora* and vars. *Austinae* and *quercifolia*.

present in anthesis; lower leaves opposite, uppermost often alternate, the lower oblong to ovate, 1.5–3.5 cm. long, 0.5–1.5 cm. broad, pinnately but usually shallowly lobed, the 3–7 lobes oblong to triangular-ovate, entire or 1–2-toothed, obtuse or acute, thin and venose, thinly hispid, upper leaves shorter petioled; flowers solitary in the axils or opposite the leaves; calyx broadly campanulate, lobes lanceolate-oblong, 4–6 mm. long, 2 mm. broad, auricles 1–2 mm. long; corolla broadly campanulate or pelviform, white or bluish, 7–12 mm. broad, obovate lobes about equalling tube, slightly erose and pilose distally; corolla-scales broad, cuneate, free edge fimbriate; filaments about equalling tube, anthers oblong, 1.5–2.5 mm. long; style 2–5 mm. long, divided about ½; mature capsule globose or nearly so, 4–7 mm. in diameter, exceeded by strongly accrescent calyx; seeds 2–4, cylindric-oblong or ovoid, 3–4 mm. in diameter, yellowish brown, regularly pitted in rows; cucullus very small and flat, deciduous.

Type locality.—"Growing in warm, loose soil under *Pinus ponderosa,* Salmon River hill, beyond Florence, Idaho County," Idaho, July 1, 1895, *L. F. Henderson* 3082.

Range.—Snake River drainage system of Washington, Oregon, and Idaho; Upper Sonoran and Arid Transition zones, in shade of rocks or bushes.

Specimens examined.—IDAHO. Locality uncertain: "Snake Country, California," *Tolmie* 23 (G, K). Idaho Co.: Salmon River Hill, *Henderson* 3082 (US: type of *N. Kirtleyi,* CU, G, UC, UO); opposite Sheep Creek, *F. G. Meyer* 278 (Thompson). Lemhi Co.: Shoup, *R. J. Davis* 414 (UC). Nez Perce Co.: Wild Goose Creek, *Constance, Rollins & Dillon* 1545 (CA, G, M, S, Thompson, UC, US, Wil, WS). Washington Co.: Mann Creek, *R. J. Davis* 1076 (UC); Olds Ferry, *Christ* 9370 (UC).

WASHINGTON. Whitman Co.: Indian, *St. John* 7630 (M, NY, UC, WS); Interior, *St. John* 6354 (M, NY, RM, UC, UO, S, WS). Asotin Co.: Grande Ronde River, *St. John & Brown* 3886 (P, WS).

OREGON. Wallowa Co.: Battle Creek, *Peck* 18,155 (NY, S, Thompson, Wil); Horse Creek Cañon, *Leiberg & Sheldon* 8006 (M, US), 8022 (M, RM, US). Baker Co.: Huntington, *Sweetser* 11 (PA, UO); Pine Creek, *Cusick* (UO); Snake River, *Cusick* 915 (F); "Union County" (1913), *Cusick* (WS). Malheur Co.: Bully Creek, *Cusick* 2379 (CU, F, G, Jepson, M, NY, RM, S, UC, US, WS); Juniper Springs, *Leiberg* 2259 (CA, F, G, NY, P, UC, UO, US).

Gray's original description of *N. breviflora* was based upon two collections, one obtained in Utah by Watson, and one of Tolmie's, labeled only "Snake Country, California." This second collection is the first known record of the species later described as *N. Kirtleyi;* it demonstrates, moreover, that the Tolmie collection was actually obtained on the Snake River or on one of its numerous tributary streams.

The regularly pitted seed of *N. Kirtleyi,* with its reduced cucullus, resembles the seeds of *N. breviflora, N. microcalyx,* and *N. phacelioides.* The fact that the cucullus is deciduous and that the lower leaves are opposite suggests an affinity with the species of the Pacific slope, especially with *N. parviflora* through its Great Basin variant, var. *Austinae.* The greatly enlarged fruiting calyx again suggests *N. breviflora,* but the much larger flowers of *N. Kirtleyi* make them appear quite different, in spite of their probable relationship.

An intensive botanical survey of the Snake River drainage may reveal a number of other species of similarly restricted range. Among the plants already described from this narrowly endemic area which are not known to range any great distance from its confines are the following: *Arabis crucisetosa, Lomatium serpentinum, Mirabilis Macfarlanei, Phlox colubrina, Ribes Gooddingii,* and *Rubus Bartonianus.*

5. Nemophila pedunculata Dougl. ex Benth.

N. pedunculata Dougl. ex Benth., Trans. Linn. Soc., 17:275. 1837.
N. parviflora var. *pluriovulata* Torr. ex Wats., Bot. King Exped., 249. 1871.
N. Menziesii var. *pedunculata* K. Brandegee, Zoe, 2:365. 1891.
N. sepulta Parish, Erythea, 7:93. 1899.
N. Menziesii var. *minutiflora* Suksdorf, Deutsche Bot. Monatss., 18:133. 1900.
N. densa Howell, Fl. NW. Amer., 1:466. 1901.
N. humifusa Kellogg ex Eastwood, Bull. Torrey Club, 28:141. 1901.
N. nana Eastwood, *op. cit.*, p. 151.
N. exigua Eastwood, *op. cit.*, p. 157.
N. alata Eastwood, *op. cit.*, p. 158.
N. minutiflora Suksdorf, W. Amer. Scient., 14:32. 1903.
N. reticulata Suksdorf, *op. cit.*, p. 32.
N. erosa Suksdorf, *op. cit.*, p. 33.
N. mucronata Eastwood ex Sheldon, Bull. Torrey Club, 30:309. 1903.
N. sepulta var. *densa* Brand, Univ. Calif. Publ. Bot., 4:211. 1912.
N. sepulta var. *minutiflora* Brand, Pflanzenr., IV. 251. 52. 1913.
N. pedunculata var. *typica* Brand, *op. cit.*, p. 53.
N. pedunculata var. *typica* forma *humifusa* Brand, *op. cit.*, p. 53.
N. pedunculata var. *typica* forma *Chandleri* Brand, *op. cit.*, p. 53.
N. pedunculata var. *typica* forma *erosa* Brand, *op. cit.*, p. 53.
N. pedunculata var. *Bakeri* Brand, *op. cit.*, p. 54.
N. eriocarpa Gandoger, Bull. Soc. Bot. Fr., 65:64. 1918.
N. nevadensis Gandoger, *op. cit.*, p. 64.
N. pedunculata var. *sepulta* Nelson & Macbride, Bot. Gaz., 65:65. 1918.
N. pedunculata var. *densa* Nelson & Macbride, *op. cit.*, p. 66.
Viticella pedunculata Macbride, Contr. Gray Herb., 59:32. 1919.
V. pedunculata var. *densa* Macbride, *op. cit.*, p. 32.
V. pedunculata var. *sepulta* Macbride, *op. cit.*, p. 32.
Nemophila insularis Eastwood ex J. T. Howell, Proc. Calif. Acad., ser. 4, 21:282. 1935.

Stems weak, more or less succulent, obscurely angled or winged, 1–3 dm. long, sparsely hispid or soon glabrate; blades of cotyledons oblong or oval, 6–12 mm. long, 2–5 mm. broad, tapering into a slender petiole of about equal length, withering before completion of anthesis; leaves all opposite, oblong to oval, 0.5–3.5 cm. long, 0.5–2 cm. broad, obtuse, slightly cuneate at base, pinnately, deeply divided into 5–9 short, oblong to obovate divisions, obtuse or acute, entire or the larger 1–2-toothed, petioles equalling blades or shorter, moderately winged, upper leaves similar, all appressed-hispid with short, often pustulate hairs, rather thick and herbaceous in texture; flowers solitary in the axils on short pedicels; calyx broadly campanulate, lobes linear to ovate-lanceolate, 1–3 mm. long, 0.5–1.5 mm. broad, acute, auricles reflexed, 0.5–1.5 mm. long; corolla pelviform or campanulate, 3–6 mm. broad, white or pale blue, and usually veined or spotted with black, blue or purple, or each

lobe with a terminal purple blotch, lobes oblong to obovate, equalling or exceeding tube, entire or erose and often sparsely pilose distally; corolla scales narrowly linear, free edge hairy, or reduced to hairy lines; filaments about equalling tube, anthers oblong, about 0.3 mm. long; style a little less than 1 mm. long, cleft about ½; mature capsule 3–6 mm. in diameter, exceeding the weakly accrescent calyx; seeds usually 2–8, ovoid, olive-green or light or dark brown, smooth or somewhat corrugated, 1–4 mm. long; cucullus usually papillaeform and often prolonged at one side, deciduous.

Type locality.—"On the Columbia" (near Fort Vancouver, Clark County, Washington), 1825, *Douglas.*

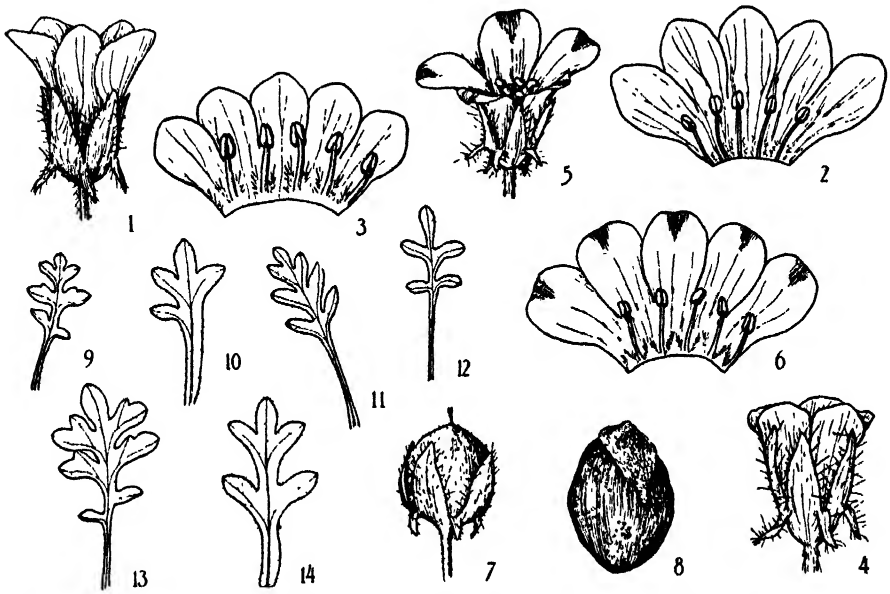


Fig. B. *N. pedunculata.* 1–2, corolla, no. 2183, × 3; 3–4, corolla, no. 2093, × 5; 5–6, corolla, *Mathias* 1374, × 5; 7, fruit × 3; 8, seed × 7½; 9–14, leaves × 1.

Range.—Baja California to British Columbia and east to western Idaho and Nevada; wet open places or in light shade, chiefly Upper Sonoran, Transition, and Canadian zones.

Specimens examined. — BRITISH COLUMBIA. Cedar Hill (1887), *Macoun* (NY, US); Nonoose, *W. R. Carter* 599 (BC, G); Vancouver's Island (1858), *Lyall* (G-part, K); Victoria, *Macoun* 78,662 (CU, F, UC), 78,661 (F, UC).

WASHINGTON. Clallam Co.: Sequim, *J. M. Grant* 916 (NY, WS). Cowlitz Co.: Kelso, *G. N. Jones* 6289 (PA, UC, UW). Clark Co.: "on the Columbia" (1825), *Douglas* (K: type of *N. pedunculata*); Lake River, *Suksdorf* 2315 (WS: type of *N. erosa*, F, G, M, NY, UC, US). Klickitat Co.: Rockland, *Suksdorf* 2638 (F, M, S, UC, WS: isotypes of *N. eriocarpa* and *N. pedunculata* f. *Chandleri*); Falcon Valley, *Suksdorf* 684 (WS: type of *N. reticulata*, M, S, UC, UO, US), *Suksdorf* 2198 (WS: type of *N. Menziesii* var. *minutiflora*, F, G, M, NY, UC, US); western Klickitat County (1884), *Suksdorf* (F, G, M, NY, PA, US).

OREGON. Locality uncertain: "Columbia woods." *Nuttall* (K, PA). Columbia Co.: Saint Helens (1880), *T. Howell* (UO). Multnomah Co.: Portland

(1882), ***Drake*** (UO). Washington Co.: Forest Grove (1894), ***F. E. Lloyd*** (NY). Clackamas Co.: Oregon City (1898), ***T. Howell*** (UC); Gladstone (1895), ***Gorman*** (PA, S, Wil), ***T. Howell*** 1943 (NY, UO). Polk Co.: Monmouth, ***Spillman*** 252 (F); West Salem, ***J. C. Nelson*** 2023 (G). Yamhill Co.: McMinnville, ***Henderson*** 1376 (M). Marion Co.: Salem, ***Peck*** 5748 (Wil), ***J. C. Nelson*** 1118 (G). Benton Co.: Corvallis, ***Gilbert*** 681 (OS), ***W. E. Lawrence*** 1278 (US). Lane Co.: Eugene (1924), ***Constance*** (UC). Douglas Co.: Roseburg, ***Peck*** 14,794 (Wil). Josephine Co.: Savage Creek, ***Henderson*** 4766 (S, UO), 5766 (CA, M, RM); Eight Dollar Mountain, ***Henderson*** 5765 (CA-part, RM, S, UO). Jackson Co.: Siskiyou Camp, ***Henderson*** 13,167 (UC, UO); Gold Hill, ***Peck*** 14,754 (NY, Wil); Wimer, ***E. W. Hammond*** 289*B* (M, NY, US). Hood River Co.: Hood River, ***Henderson*** 472 (M, WS). Wasco Co.: The Dalles (1860), ***Lyall*** (G), ***Sheldon*** 10,185 (F, G, M, NY, P, S, Thompson, UO, US, WS); Chenowith Creek, ***Sheldon*** 10,204 (F, G, M, NY, P, PA, UO, US, WS: isotypes of *N. mucronata*); Maupin, ***Peck*** 17,319 (NY, S, Wil). Union Co.: ***Cusick*** 872 (F-part, G, PA-part). Grant Co.: Mount Vernon, ***Henderson*** 5088 (CA, G, M, S, UO); John Day Valley (1885), ***T. Howell*** (OS, PA, UO). Wheeler Co.: Mitchell (1894), ***T. Howell*** (UC). Crook Co.: Crooked River, ***Leiberg*** 250 (F, G, M, NY, P, PA, RM, S, UO, US). Klamath Co.: Topsy, ***Applegate*** 2054 (S, US); McCullom's Mill, ***Henderson*** 9353 (CA, S, UO). Lake Co.: Lakeview, ***Peck*** 15,477 (NY, Wil). Harney Co.: Alvord Ranch, ***Peck*** 14,011 (F, S, Wil); Burns, ***Henderson*** 6700 (UO). Malheur Co.: Owyhee–Malheur Divide, ***Leiberg*** 2180 (F, G, NY, P, UC); Jordan Valley (1927), ***Henderson*** (UO).

IDAHO. Washington Co.: Salubria (1900), ***M. E. Jones*** (P). Adams Co.: New Meadows, ***R. J. Davis*** 811 (UC); Council, ***R. J. Davis*** 810 (UC).

NEVADA. Eureka Co.: Victory Highway (1933), ***Eastwood & Howell*** (CA). Washoe Co.: Washoe Lake (1897), ***M. E. Jones*** (P). Ormsby Co.: King's Cañon, ***C. F. Baker*** 914 (CA, G, M, NY, P, RM, UO, US: isotypes of *N. nevadensis* and *N. pedunculata* var. *Bakeri*). Douglas Co.: Clear Creek, ***Mathias*** 1374 (UC).

CALIFORNIA. Locality uncertain: "California" (1838), ***Douglas*** (G, K). Modoc Co.: Goose Lake Valley, ***Austin*** 640 (P, US); Fort Bidwell, ***Manning*** 107 (UC, US); Rush Creek, ***Constance*** 2337. Siskiyou Co.: Yreka, ***Greene*** 716 (F, G, M, PA), ***Butler*** 1302 (M, P, RM, S, UC, US), ***Butler*** 658 (CA, Jepson, UC); Bartles Station, ***Hall & Babcock*** 4121 (S, UC); Mount Eddy, ***Heller*** 13,394 (F, M, NY, S, US). Lassen Co.: McKenzie Meadows, ***Constance*** 2323. Shasta Co.: Goose Valley, ***Eastwood*** 730 (CA, M, NY, US); Hatchet Mountain, ***Constance*** 2338. Trinity Co.: Post Creek Mountain, ***Tracy*** 6481 (UC). Humboldt Co.: Hydesville, ***Tracy*** 2434 (G, UC, UO, US); Eureka, ***Tracy*** 4779 (Jepson, UC), 4784 (Jepson, UC). Plumas Co.: (187–), ***Austin*** (F, K); Red Clover Valley, ***Heller & Kennedy*** 8734 (CA, F, G, M, NY, P, PA, S, UC, US); Sierra Valley, ***Stebbins & Jenkins*** 2141 (S, UC); Chester, ***Constance*** 2320. Butte Co.: Chico, ***Heller*** 11,852 (CA, Clokey, CU, F, G, M, NY, OS, PA, S, US); Clear Creek, ***H. E. Brown*** 173 (CA: type of *N. alata,* G, M, NY, S, UC, US), ***Heller*** 13,606 (CA, F, G, M, NY, P, RM, S, Thompson, UC, UO, US). Placer Co.: Cisco, ***Constance*** 2278. Glenn Co.: Willows, ***Eastwood*** 11,157 (CA); Stony Creek, ***Constance & Morrison*** 2188. Tehama Co.: Paskenta, ***Constance & Morrison*** 2183. Colusa Co.: Lodoga, ***A. Carter*** 1381 (UC). Trinity Co.: South Fork Mountain, ***Jepson*** 16,661 (Jepson-part) Lake Co.: Cache Creek, ***Constance*** 2145; Bartlett Springs, ***Mason*** 11,744 (UC), 11,745 (UC); Bartlett Mountain (1900), ***Eastwood*** (CA: type of *N. nana*); Lower Lake,

Chandler 1505 (P, US). Sierra Co.: Sierra Valley, *Lemmon* 168 (M, PA) and (1875) (G, S, UC, US); Yuba Pass, *Constance* 2303. Sutter Co.: North Butte, *Wieslander* 381 (VTM). Napa Co.: "crater," *M. S. Baker* 4032 (Baker). Mendocino Co.: Albion River, *J. McMurphy* 105 (S). Solano Co.: Vaca Valley (1878), *Rattan* (S-part). Eldorado Co.: Shingle Springs–Eldorado, *Heller* 12,295 (CA, F, G, M, NY, OS, PA, S). Amador Co.: Stony Creek, *Hansen* 1522 (CA: type of *N. exigua*, S, UC); Drytown, *Hansen* 2064 (M); Plymouth, *Constance & Morrison* 2165. Calaveras Co.: Murphy's–Big Trees (1934), *H. F. Copeland* (P, S); Avery, *Tracy* 5716 (Jepson). San Joaquin Co.: Midway, *Mason* 6824 (UC); Corral Hollow, *Constance & Beetle* 2525. Stanislaus Co.: Modesto, *Hoover* 1630 (Hoover, Jepson, UC); Oakdale, *Abrams* 9981 (S). Contra Costa Co.: Antioch, *Mason* 6841 (UC); Donner Canyon, *Bowerman* 1831 (UC); Mitchell Cañon, *Ottley* 455 (CU). Alameda Co.: Arroyo Mocho (1925), *J. T. Howell* (CA). San Francisco Co.: San Francisco, *Kellogg* (CA: type of *N. humifusa*), *Chandler* 1800 (P, RM, S, UC, US); Lone Mountain, *Kellogg & Harford* 783 (CA, G, NY, US); Lake Merced, *Gardner* 547 (P, RM, UC, US), *Chandler* 6073 (F, G, M, NY, P, PA, RM, S, UC, UO, US, UW). San Mateo Co.: *Abrams* 5584 (S). Santa Clara Co.: Alameda Creek, *Ferris & Bacigalupi* 8280 (G, S); El Toro, *Constance & Hoover* 2048; Isabel Creek, *Chandler* 6037 (F, G, M, NY, P, PA, RM, S, UC, UO, US, UW), 6039 (F, G, M, NY, P, PA, RM, S, UC, UO, US, UW); Mount Hamilton, *Sharsmith & Sharsmith* 581 (UC). San Benito Co.: Hernandez, *Constance & Morrison* 2270; Tres Piños Creek, *Constance & Hoover* 2068. Tuolumne Co.: Duffield's Ranch, *Bigelow* 43 (G, NY); Indian Creek, *Ferris* 1643 (CA, Clokey, P, S, US); Keystone, *Abrams* 10,056 (NY, S). Mariposa Co.: Blochman's Ranch (1915), *Eastwood* (CA); Mariposa Creek, *Constance & Mason* 2127. Monterey Co.: King City, *Eastwood* 4024 (CA, G); Jamesburg, *Constance & Hoover* 2051. Fresno Co.: Waltham Creek Canyon, *Constance & Beetle* 2562. Tulare Co.: Porterville (1897), *Dudley* (S). San Luis Obispo Co.: Estrella Creek, *Constance* 2087. Kern Co.: Cottonwood Canyon, *Constance* 2093; Hobo Hot Springs, *Constance & Mason* 2118; Mount Piños, *H. M. Hall* 6430 (UC). Ventura Co.: Frazier Mountain, *H. M. Hall* 6605 (UC), San Nicolas Island, *J. T. Howell* 8213 (CA: type of *N. insularis*). Santa Barbara Co.: Roble Creek, *H. M. Hall* 7810 (RM, UC); San Miguelito Canyon, *Munz* 10,265 (P, UC); Santa Inez Mountains (1888), *T. S. Brandegee* (S, UC); San Miguel Island (1930), *Hoffmann* (CA); Santa Cruz Island (1888), *T. S. Brandegee* (Jepson, UC); Santa Rosa Island (1929), *Hoffmann* (CA). Los Angeles Co.: Alamo Creek (1931), *Hoffmann* (P). San Bernardino Co.: Bear Valley, *Parish* 10,884 (G, M, NY, S, UC), 3130 (G, M, NY, US), 3782 (S: type of *N. sepulta*, CA, F, G, UC, US), 1842 (CA, F, G, M, S, UC, US), 4908 (P, NY, S, UC, US); Green Valley, *Munz* 13,241 (P, US); "Southern California," *Parry & Lemmon* 256 (F, G, M, NY, US). Riverside Co.: San Carlos Pass, *Munz* 10,845 (P). San Diego Co.: Witch Creek, *Chandler* 5022 (S, UC).

Baja California. Japa Valley, *Orcutt* 1128 (G-part, M-part, US-part).

In spite of the abundant synonymy, which has been created chiefly by describing color forms and habital modifications, most recent authors have recognized only two species, *N. pedunculata* and *N. sepulta*, in the group treated here as a single specific entity. Nelson and Macbride (1918, pp. 65–68) reduced the latter to subordinate status under the former and pointed out the

Map 3. Distribution of *N. pedunculata.*

weakness of its supposed characters. Habit, foliage, pubescence, and inflorescence being closely similar, it has been customary to emphasize the few (less than 5) large seeds and broadly campanulate corolla of *N. sepulta* as contrasted with the more numerous (5–12) and smaller seeds and "tubular to tubular-campanulate" flower of *N. pedunculata.* Attempts to correlate color and shape of the corolla with number of seeds, however, have not been highly successful, for these structures seem to be independently variable. The only criterion for separation, then, is the number of ovules and seeds and the associated character of size of seeds. It is certainly true that seed number is more or less constant in individual plants, in certain colonies, and even over wide geographical areas, 2-seeded, 4-seeded, and 5–8-seeded types being the most common. Whether the species contains few-ovuled biotypes and many-ovuled biotypes, which have occupied different portions of the specific range, or whether the number of ovules is directly referable to definite sets of environmental factors cannot be stated with authority at present. Whatever the explanation, few-ovuled plants have been collected from the San Bernardino Mountains (type locality of *N. sepulta*), north to, and beyond, the Columbia River (type locality of *N. pedunculata*). Many-ovuled plants, however, have been seen from southern Vancouver Island to Baja California. Plants intermediate in number and size of seeds are known from Vancouver Island, Washington, Nevada, and many localities in California, and many sites contain both few- and many-ovuled plants which are otherwise indistinguishable. Because no clear geographical segregation has yet been achieved in this species, and because the plants exhibit parallel variations in other structures and are so similar in flowers and foliage, I cannot justify even a varietal distinction.

The pedicels deflex at maturity so that the apices of the capsules are brought in contact with the surface of the ground, a position which has given rise to the belief that this species "buries" its fruits. However, unless the plants grow in sand, the ground is usually dry and hard when the capsules are mature, and no mechanism is known which would enable the plant to push the fruits into the earth, although they are often covered by soil blown or washed over them.

This is the most widely distributed species of its genus, occurring from several thousand feet altitude to nearly sea level, from British Columbia to Baja California. It is chiefly a plant of moist or wet open places, but may grow also in light shade. It is also the only one of the small-flowered species to occur upon any of the California islands.

The closest relative of *N. pedunculata* is doubtless *N. Menziesii* var. *integrifolia,* with specimens of which it is frequently confused in collections from Baja California. The leaves and seeds of the two are nearly identical, but the corollas are very distinct, and when var. *integrifolia* becomes diffuse its upper leaves are reduced and less lobed, whereas all the leaves of *N. pedunculata* are substantially the same, no matter what the form or duration of growth. There is probably a relationship, also, between *N. spatulata* and *N. pedunculata*

lata, the two being similar in environment preference, growth form, calyx, form and color of the corolla, and the fruit.

6. **Nemophila Menziesii** Hook. & Arn.

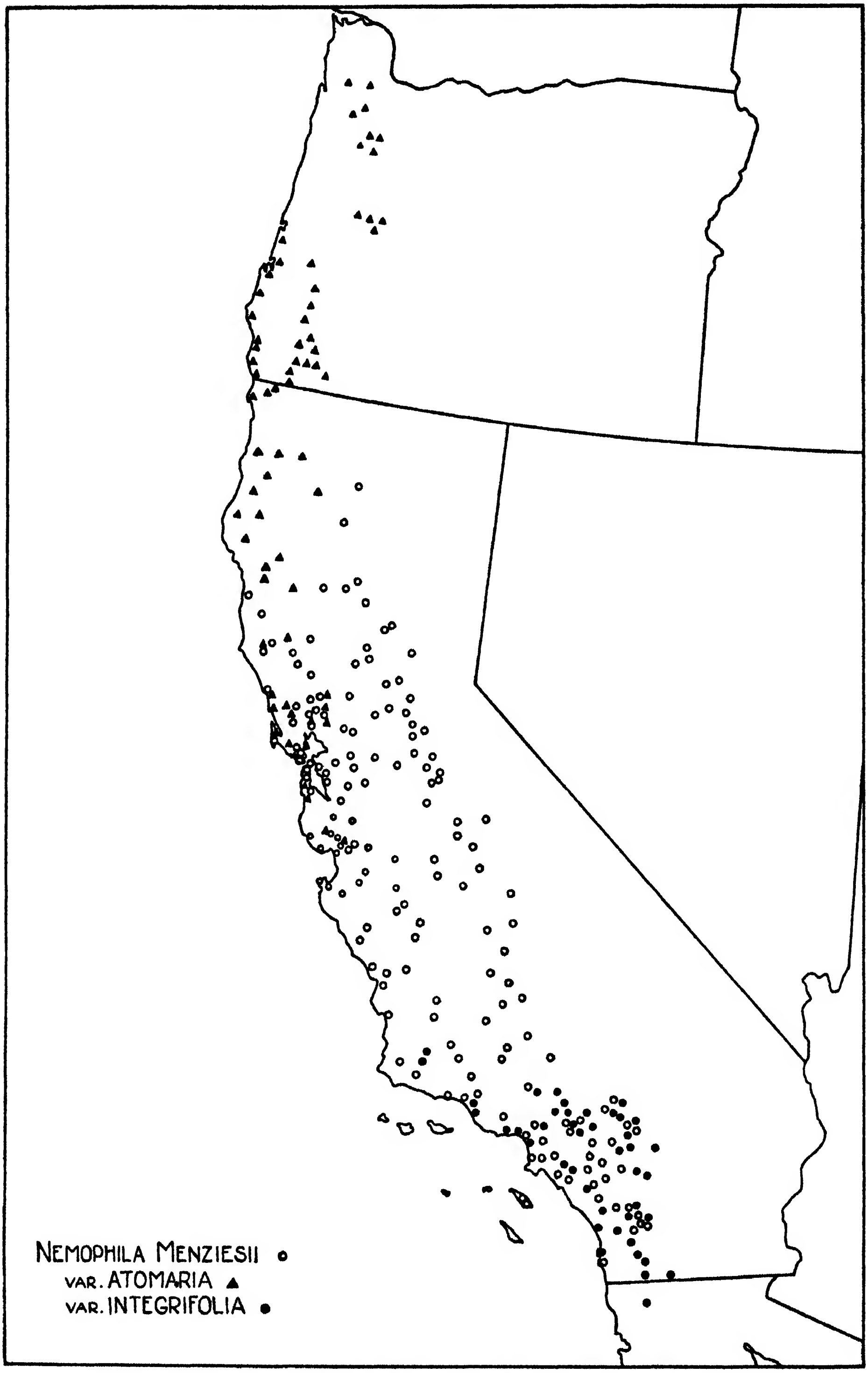
N. Menziesii Hook. & Arn., Bot. Beechey Voy., 152. 1833.
N. insignis Dougl. ex Benth., Trans. Linn. Soc., 17:275. 1834.
N. insignis var. *Menziesii* A. DC. ex DC., Prodr., 9:290. 1845.
N. liniflora Fisch. & Mey., Sert. Petrop., t. 8. 1846.
N. modesta Kellogg, Proc. Calif. Acad., 7:93. 1877.
N. intermedia Bioletti, Erythea, 3:141. 1895.
N. insignis var. *intermedia* Jepson, Fl. West. Mid. Calif., 434. 1901.
N. venosa Jepson, *op. cit.*, p. 434.
N. Brandegei Eastwood, Bull. Torrey Club, 29:471. 1902.
N. maculata var. *concolor* Brand, Univ. Calif. Publ. Bot., 4:210. 1912.
N. Menziesii subsp. *insignis* Brand, *op. cit.*, p. 210.
N. Menziesii subsp. *insignis* var. *Brandegei* Brand, *op. cit.*, p. 210.
N. Menziesii subsp. *insignis* var. *typica* Brand, *op. cit.*, p. 210.
N. Menziesii subsp. *insignis* var. *typica* subvar. *acaulis* Brand, *op. cit.*, p. 210.
N. Menziesii subsp. *insignis* var. *minor* Brand, Pflanzenr., IV. 251. 48. 1913.
N. Menziesii subsp. *insignis* var. *minor* forma *arenaria* Brand, *op. cit.*, p. 48.
N. Menziesii. subsp. *liniflora* Brand, *op. cit.*, p. 48.
N. Menziesii subsp. *liniflora* var. *intermedia* Brand, *op. cit.*, p. 48.
N. Menziesii subsp. *liniflora* var. *venosa* Brand, *op. cit.*, p. 48.
Viticella Menziesii Macbride, Contr. Gray Herb., 59:30. 1919.
V. Menziesii var. *liniflora* Macbride, *op. cit.*, p. 30.
Nemophila Evermanni Eastwood, Proc. Calif. Acad., 20:152. 1931.

Stems obscurely angled or winged, 1–3 dm. long, pubescent with some afflexed, reflexed or spreading hairs; blades of the cotyledons oval or oblong, 5–10 mm. long, 3–6 mm. broad, tapering into an equally long or shorter petiole; leaves all opposite, the lower linear-oblong to oval, 2–5 cm. long, 0.8–2.5 cm. broad, pinnately divided into usually 9–11 oblong to orbicular, obtuse divisions, entire or the larger 1–3-toothed, petioles of about equal length, uppermost leaves short petioled with fewer and narrower lobes, occasionally only shallowly lobed or toothed, all loosely appressed-hispid with often pustulate hairs; flowers solitary in the axils on slender pedicels which exceed the leaves; calyx broadly campanulate to nearly rotate, lobes lanceolate, 4–6 mm. long, 1–3 mm. broad, acute, auricles linear or lanceolate, 1.5–2.5 mm. long, reflexed; corolla pelviform or semirotate, 1.5–4 cm. broad, bright blue with a white center, or conspicuously blue-venose, and often punctate centrally, lobes obovate or oblong, exceeding tube, rounded and erose; corolla scales broad or narrow, partly free or adherent or reduced to hairy lines or obsolete; filaments about equalling tube, anthers narrowly oblong, 2–2.5 mm. long; style slender, 3–5 mm. long, divided about ½, conspicuously exserted from calyx; mature capsule globose or ovoid, 0.5–1.5 cm. in diameter; seeds usually 10–20, ovoid or oblong, about 2 mm. long, dark brown or black, conspicuously corrugate-tuberculate; cucullus often papillaeform, deciduous.

Type locality.—"California" (possibly collected at Monterey), *Menzies.*

Range.—Throughout cismontane California, from San Diego to Mendocino and Shasta counties; Upper Sonoran and Transition zones, chiefly in open places.

Specimens examined. — CALIFORNIA. Locality uncertain: "California," *Bridges* 170 (G, NY, US), *Coulter* 475 (G, K), 479 (G, K, NY), *Douglas* (K: type of *N. insignis*, G, NY), *Menzies* (K: type of *N. Menziesii*); without locality, *Fremont* 217 (K, M, NY), 162 (G, K, NY). Mendocino Co.: Handley's, *J. McMurphy* 104 (NY, S, US); South Mill Creek Cañon, *Abrams* 6954 (NY, S). Sonoma Co.: Bodega (1901), *Eastwood* (UC, US: topotypes of *N. liniflora*); Bodega Point, *Eastwood* 4819 (G, US); Kenwood (1902), *M. S. Baker* (S, UC, US); Knight's Valley, *H. Edwards* 78 (CA, NY); Santa Rosa, *Heller & Brown* 5116 (F, G, M, NY, PA, S, US). Lake Co.: Bartlett Springs, *Mason* 11,742 (UC); Cache Creek, *Constance* 2144; Sulphur Banks (1903), *Bowman* (G, S). Napa Co.: Calistoga, *Tracy* 1839 (UC, UO, US); Howell Mountains, *Constance* 2033; Mount Saint Helena, *Eastwood* 6843 (CA, Clokey); Napa Valley, *Thurber* 495 (F, G, NY); Pope Valley, *Crum* 1738 (CA, F, NY, P, RM, S, UC, UO, US, UW); Yountville (1898), *Peckinpah* (Jepson: type of *N. venosa*). Shasta Co.: Crafton–Redding (1876), *Lemmon* (F, UC, US); McClouds Fork, *L. E. Smith* 117 (CA); Fort Redding, *Newberry* (US). Tehama Co.: Paskenta, *Constance & Morrison* 2180. Colusa Co.: College City (1908), *A. King* (Jepson). Yolo Co.: Buckeye Creek, *Ferris* 708 (M, NY, S). Sutter Co.: Sutter City, *Heller* 7569 (F, G, M, NY, PA, S, US); Valley of Butte Pass, *Jepson* 15,088 (Jepson). Butte Co.: Chico (1902), *W. Paine* (P, RM, S, UC, US); Clear Creek, *H. E. Brown* 145 (F, M, NY, S, US), 252 (UC: isotype of *N. maculata* var. *concolor*); Little Chico Creek (1883), *Austin* (F, PA, US), *Bruce* 2036 (NY, P, S); Oroville, *Heller* 11,179 (CA, CU, F, G, M, NY, PA, OS, S, UC, US). Plumas Co.: (1876), *Austin* (F). Nevada Co.: Penn Valley, *Jepson* 15,093 (Jepson, US). Placer Co.: Auburn (1878–85), *Ames* (F, G, NY, PA, UO). Eldorado Co.: Hastings Creek, *Jepson* 18,591 (Jepson); Nashville, *Jepson* 18,654 (Jepson); Rose Springs (1879), *Gates* (UC); Shingle Springs–Eldorado, *Heller* 12,296 (CA, CU, F, G, M, NY, OS, PA, S, US). Sacramento Co.: Del Paso Park, *Heller* 13,382 (F, M, NY, S, US); Sacramento (1900), *M. S. Baker* (P, UC). Solano Co.: Elmira (1878), *Rattan* (S); Rocky Peak, *Jepson* 15,091 (Jepson). Marin Co.: Olema, *Davy* 681 (UC); Mount Tamalpais, *Eastwood* 2502 (CA, Clokey, G, NY); Angel Island, *Michener & Bioletti* (UC). San Francisco Co.: Lake Merced (1892), *Michener & Bioletti* (NY, UC, US); Potrero, *Kellogg & Harford* 787 (CA, G, US); San Bruno Hills, *C. F. Baker* 1895 (CA, F, G, M, NY, RM, S, US), 1970 (G, NY, P, RM, UC, US); San Francisco, *Brewer* 907 (UC, US). San Mateo Co.: La Honda, *C. F. Baker* 500 (F, G, M, NY, P, RM, S, UC, US, WS); San Bruno Hills, *Elmer* 4737 (CA, M, NY, OS, P, S, UC, UO, US). Santa Clara Co.: El Toro, *Constance & Hoover* 2047; Guadalupe Mine, *Constance* 2073 (topotypes of *N. modesta*); Los Gatos, *Heller* 7272 (F, G, M, NY, OS, PA, RM, S, UC, US); Los Troncos & San Francisquito creeks, *Abrams* 5081 (NY, P, RM, S, US); Smith Creek, *Heller* 8523 (F, G, M, NY, PA, S, US); Stanford University, *C. F. Baker* 276 (CA, F, G, M, NY, P, RM, S, UC, US, WS). Alameda Co.: Berkeley Hills, *Chandler* 1801 (P, RM, S, UC, UO, US), 6076 (F, G, M, NY, OS, P, PA, RM, S, UC, UO, US, UW); Cedar Mountain, *Mason* 2828 (UC); Claremont Canyon, *Constance & Mason* 2032; Oakland, *Brewer* 2764 (M, UC, US); San Leandro Creek, *H. M. Hall* 2701 (G, P, PA, RM, S, UC, US). Contra Costa Co.: Antioch, *Mason* 6837 (UC); Byron Springs, *Eastwood* 3789 (CA, G, NY, US); Mitchell Canyon, *Bowerman* 557 (UC); Mount Diablo, *Eastwood* 4494 (CA, US). San Joaquin Co.: Peters, *Stanford* 832 (G, P); Tracy, *C. F. Baker* 2868 (F, G, M, NY, P, RM, UC, US: isotypes of *N. Menziesii* f. *arenaria*). Amador Co.: Agricultural



Map 4. Distribution of *N. Menziesii* and vars. *atomaria* and *integrifolia*.

Station, New York Falls, *Hansen* 87 (M, S); Antelope, *Hansen* 1677 (M, US); Sugar Loaf, *Nordstrom* 762 (UC, VTM). Calaveras Co.: Angels Camp, *Eastwood* 11,629 (CA); Calaveras River (1850), *C. D. Gibbes* (NY); Murphy's–Big Trees (1934), *H. F. Copeland* (P, S). Stanislaus Co.: LaGrange (1890), *M. S. Baker* (UC). Tuolumne Co.: French Flat, *Ferris* 1536 (CA, Clokey, P, S, US); Jamestown, *A. L. Grant* 621 (Jepson); Keystone, *Abrams* 10,055 (Clokey, NY, S, UC, US). Mariposa Co.: Aqua Fria trail (1903), *Congdon* (M, US); Blochman's Ranch, *Eastwood* 4364 (CA, Clokey, G, NY, US); Mariposa Creek, *Constance & Mason* 2126. Madera Co.: Coarse Gold, *Hoover* 3524 (Hoover, UC); Fairmead, *Abrams* 10,780 (P, S); Kelshaw Corners, *Constance* 2199; Madera, *Mason* 5108 (UC); Pollasky, *Heller* 8132 (CA, F, G, M, NY, PA, S, US). San Benito Co.: Idria, *Ferris* 7038 (P, S), *Constance & Morrison* 2263; Tres Piños Creek, *Constance & Hoover* 2069. Merced Co.: Los Baños, *Eastwood* 14,103 (CA). Santa Cruz Co.: Año Nuevo Pines, *J. T. Howell* 10,977 (CA, G, P, US); Deer Ridge Farm, *Heller* 8436 (F, G, M, NY, PA, S, US); Glenwood (1909), *R. J. Smith* (PA, UC). Monterey Co.: Bardino, *Elmer* 4839 (CA, M, NY, OS, P, S, UC, UO, US); Del Monte, *Elmer* 3519 (G, M, NY, P, S, UC, US) and (1903), *Heller* (G, M, NY); Jamesburg, *Constance & Hoover* 2052; Mansfield's Ranch, *Eastwood* 4034 (CA, Clokey, US); Monterey, *Hartweg* 169 (G, K); Pacific Grove, *Eastwood* 2466 (CA, G, M, S, US); Santa Lucia Mountains, *Plaskett* 46 (G, NY-part, US). Fresno Co.: Coalinga, *Munz* 9168 (P, UC, US); Pinehurst, *Constance* 2218; Tollhouse, *Constance* 2215; Waltham Creek Canyon, *Constance & Beetle* 2559; Zapato (1893), *T. S. Brandegee* (CA: type of *N. Brandegei*). Tulare Co.: Dana's Ranch (1850), *Parry* (NY, US); Elizabeth Lake, *H. M. Hall* Richgrove, *Munz* 9014 (P, UC); Tulare, *Davy* 3102 (UC). Kern Co.: Famosa, *Mathias* 1330 (UC); Fort Tejon, *Xantus* 87 (G, NY, PA, US); Girard Station, *Heller* 7710 (F, G, M, NY, PA, S-part, UC, US); Isabella, *Constance & Mason* 2116; Tehachapi Pass, *Peirson* 5478 (Peirson, UC); Walker Pass (1915), *Evermann* (CA: type of *N. Evermanni*). San Luis Obispo Co.: Bitterwater Valley–Carisa Plains, *Wiggins* 5821 (NY, P, S, UC); Morro Bay (1882), *Summers* (M, P, RM, UC, UO, US); Paso Robles, *Constance* 2086. Santa Barbara Co.: Figueroa Mountain, *Mason* 11,807 (UC); Foxen's Ranch, *Brewer* 406 (NY, UC, US); Spanish Ranch, *N. French* 757 (UC, VTM). Ventura Co.: Santa Susanna Mountains, *Brewer* 216 (UC, US). Los Angeles Co.: Dana's Ranch (1850), *Parry* (NY, US); Elizabeth Lake, *H. M. Hall* 3064 (S, UC, UO, US); Elysian Park, *Braunton* 836 (S, UC, UO); Los Angeles (1888–91), *Hasse* (M, NY, P, US); North Pomona, *Braunton* 216 (UC, US); San Gabriel River, *Leiberg* 3406 (UO, US); Santa Catalina Island (1896), *Trask* (F, M, US). Orange Co.: Anaheim Plains (1908), *A. King* (Jepson); Trabuco Canyon, *C. B. Wolf* 1848 (S, UC). San Bernardino Co.: Cajon Pass, *Bigelow* 45 (G, NY, PA, US), *Hall & Chandler* 6753 (F, G, NY, P, PA, RM, S, UC, UO, US, UW); San Bernardino, *Parish & Parish* 25 (F, M, NY, PA, S, US); San Bernardino Mountains, *Vasey* 410 (F, UC, US). Riverside Co.: Elsinore, *C. F. Baker* 4124 (P, S, UC), *Munz* 12,023 (CU, M, P, UC); Gavilan, *H. M. Hall* 2931 (S, UC, US); Strawberry Valley, *Hall* 1806 and *Jepson* 1310 (Jepson, UC). San Diego Co.: Grapevine Cañon, *Jepson* 8747 (Jepson); Palomar Mountain, *Munz* 10,404 (P, UC); San Diego, *M. E. Jones* 3079 (CA, Clokey, G, M, NY, P, RM, S, UC, US); Santa Ysabel, *Henshaw* 194 (M, NY, US); Warner's Hot Springs, *Eastwood* 2593 (CA, Clokey, G, M, NY, P, US).

Much of the abundant literature on *Nemophila* deals with the plants comprising *N. Menziesii*. Originally, there was doubt of priority of publication as between *N. insignis* and *N. Menziesii*. When this controversy was settled in favor of the latter name, the exact identity and place of collection of Menzies'

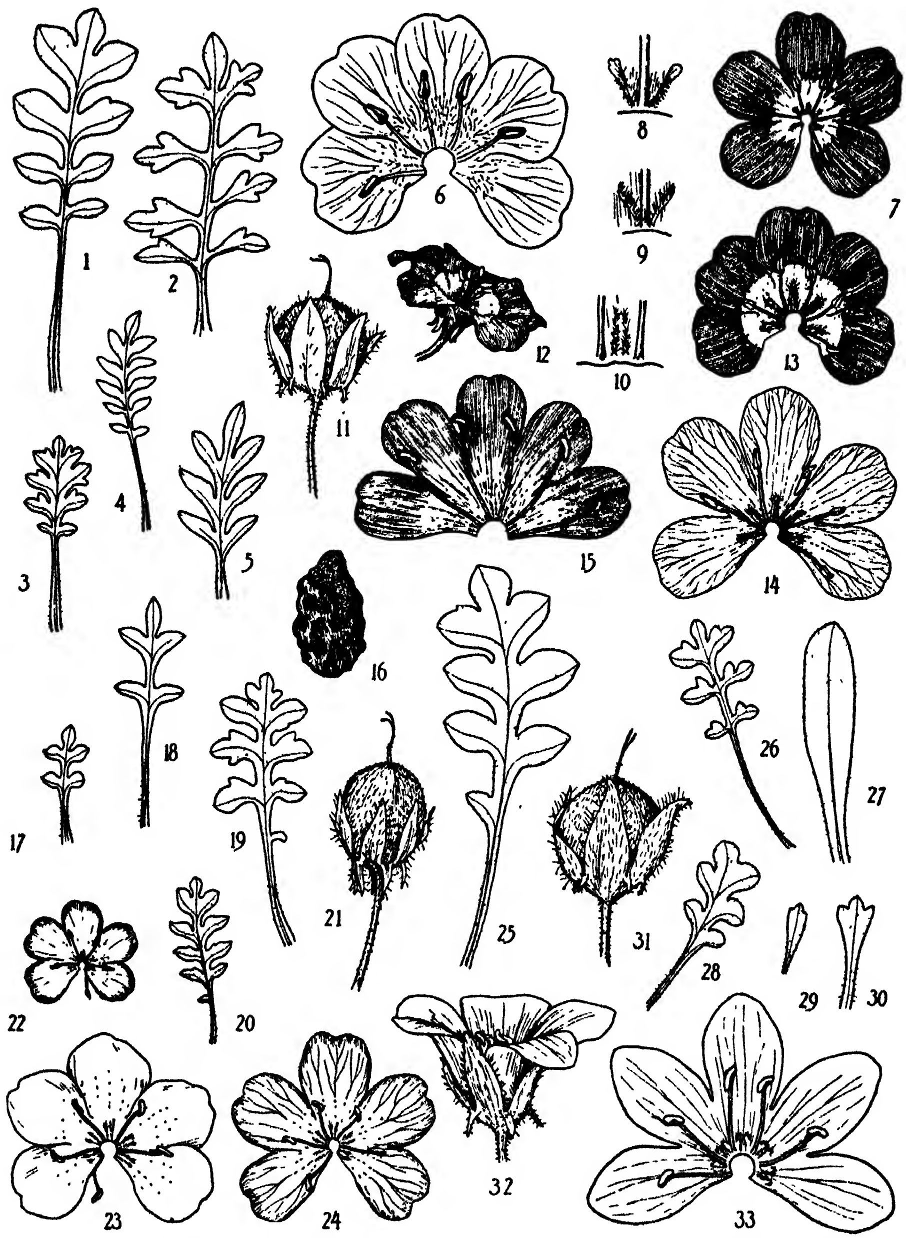


Fig. C. *N. Menziesii*. 1–5, leaves × 1; 6, corolla, no. 2073, × 3; 7, corolla, no. 2180, × 1; 8, corolla scales, no. 2218, × 3; 9, corolla scales, no. 2199, × 5; 10, corolla scales, no. 2263, × 5; 11, fruit × 2; 12–14, corolla, no. 2032, × 2; 15, corolla, no. 2263, × 3; 16, seed × 7½. Var. *atomaria*. 17–20, leaves × 1; 21, fruit × 2; 22–24, corolla, no. 2158, × 1. Var. *integrifolia*. 25–30, leaves × 1; 31, fruit × 2; 32–33, corolla × 2½.

specimens (upon which the species was based) became important problems. It was generally agreed that these belonged to the species as here understood, but it was not known which of the numerous color forms these specimens represented, or what kind of corolla scales they possessed. In my opinion, the exact identity of this classical collection is immaterial because, as the species occurs naturally in California, it would be quite possible for several of the different color phases and many modifications of corolla scales and other structures to have been obtained in the same colony. The specimens from Hooker's herbarium, now at Kew, which doubtless represent the type, certainly belong to typical *N. Menziesii* and not to either of the two varieties recognized in this paper.

In the main, the described segregates can be referred to the three most conspicuous color forms, as follows: Type I, that with a white background thickly covered with black dots (*N. atomaria, N. Johnsoni*); Type II, that with a pale ground color striped with conspicuous blue or purplish veins (*N. liniflora, N. modesta*); Type III, that with a deep blue periphery and clear white center (*N. insignis, N. Brandegei*). Bioletti (1895, p. 140) introduced *N. intermedia* to include the population of the northern Coast Ranges, which is largely a combination of the color schemes of Types II and III. Although the entity is described as a "species," he denies it such status by remarking: "The original description covers very well the whole group and this, taken in conjunction with the close resemblance of the different members, seems to render it advisable to use the name *N. Menziesii*, H. & A., to designate the whole group and to consider the divisions of the group as sub-species." Chandler (1902, pp. 201–207) recognized the same constitution of *N. Menziesii* as that adopted in the present paper, with two varieties, var. *atomaria* for Type I, and var. *integrifolia* to include the diffuse and small-flowered southern Californian phase of the species. Subsequently, Chandler (1907) extended varietal recognition to two more southern Californian plants, vars. *rotata* and *annulata*. Brand (1912, 1913) accepted approximately the same boundaries for *N. Menziesii*, but recognized a total of 4 subspecies, 11 varieties, 1 subvariety and 2 forms. His subspecies are subsp. *insignis* (Type III), subsp. *liniflora* (Type II), subsp. *atomaria* (Type I), and subsp. *australis*. The fourth subspecies was coextensive with Chandler's earlier interpretation of var. *integrifolia* except for the fact that *N. rotata* was kept specifically distinct from *N. Menziesii*. Thus, most treatments have tended to subordinate all of these plants, with the partial exception of the southern Californian, under *N. Menziesii*, but have also tended to recognize a varying number of color variants and other deviant populations as subspecies or varieties.

The results of experimental breeding of cultivated strains led Chittenden and Turrill (1926, pp. 1–12) to advocate the abandonment of *N. Menziesii* as a name, because of the impossibility of precise identification (in the sense of color phase) of the plants upon which it was based, and to recommend the elevation of Brand's four subspecies to specific status. The chief considerations

which led them to suggest this separation of elements generally supposed to be closely related were: (1) that three of the four subspecies experimented upon proved to be intersterile and thus must be distinct species, incapable of hybridization; and (2) that the basic color pattern of the corolla, or "color-zonation," is constant within each of these four subspecies and can be modified only within a limited radius that does not permit intermingling of the color schemes of any two of these four. The writers frankly pointed out that the value of their work was limited by their lack of knowledge of the wild source of the commercial seed used in the breeding studies and by the fact that neither of them had seen, in its natural habitat, any of the plants whose taxonomy they presumed to revise.

Anyone familiar with *N. Menziesii* in its native condition is aware that the individuals occur in tremendous concentrations, and that there is within each colony a high degree of variability, which may be broad enough to include all three of the chief color types plus intermediates of every grade between any or all of them. The hypothesis of hybridization might be introduced to explain the existence of such bewildering variability in a single locality, but Chittenden and Turrill have demonstrated that such interbreeding cannot occur! We are left to assume that we have four "species" which are intersterile, and which include about one-half of the individuals usually assigned to *N. Menziesii.* For the "intermediate" types, which field study shows to be often fully as numerous as the "pure," there is no available niche in this classification. It is true that certain vegetative characters were drawn into use to support the separation of the four "species," but these are equally unstable with color-zonation, which is the major consideration emphasized throughout their paper. No one, I think, will deny that there is pressing need of genetic study upon our native flora, but the treatment mentioned above vividly illustrates the fallacies which may result from too hasty application of genetic results obtained from garden material to phylogenetic classification of a polymorphic wild population.

N. Menziesii, in its natural state, is so variable a species that the segregation of any entities other than vars. *atomaria* and *integrifolia* seems to me to be impracticable. Even if it were to be shown that hybridization has played a major rôle in the creation of the existing complex, the supposedly distinct types have become so thoroughly intermingled that it is doubtful whether their taxonomic separation would be feasible. Some indications of sexual irregularity do exist, as in the occurrence of flowers with sterile anthers and the like, but it is also true that many of the plants most "intermediate" in characters apparently produce normal and viable seed. Although there are certain partial correlations of color, degree of pubescence, extent of corolla-scale development, and geographical distribution, these are not sufficiently clear-cut to make their nomenclatorial recognition anything but confusing.

The only close relative of *N. Menziesii* and its varieties seems to be *N. pedunculata,* which so closely resembles it in habit, leaf form, and seed con-

figuration that it is often confused with it, as is evident from the synonymy of *N. pedunculata*. Relationship to *N. maculata* and to *N. pulchella,* which has been postulated by previous authors, is, I believe, only apparent and based upon wholly superficial resemblances in corolla size and shape, as well as color. Hooker's (1833, p. 152) enigmatic statement that *N. Menziesii's* leaves "are precisely those of *N. parviflora,* a species found by Dr. Scouler and Mr. Douglas on the Columbia River," doubtless was a mistaken reference to *N. pedunculata,* which was also obtained on the Columbia by Douglas.

In a general way, Type III is characteristic of the Sierra Nevada foothills and the Great Valley, breaking through to the coast in several places. The coastal strip, from Santa Clara and San Mateo counties north to Mendocino County, is the habitat of Type II, which is replaced on the immediate coast and northward by Type I. The northern Coast Ranges are occupied chiefly by intermediates between Types II and III; the southern Coast Ranges, by types II and III, intermediates between them, and by a modification of Type III with conspicuous black markings at the center. The population of southern California, exclusive of the plants referred to var. *integrifolia,* seems to be another modification of Type III, in which the coloration is much more intense, the pubescence is often limited, and the leaves are more highly dissected. In all instances, however, the transition from one type to another is so gradual, the exceptions so numerous, and the confusion of the various patterns in each colony so great, that it seems unwise to attempt further segregation.

6*a*. **Nemophila Menziesii** var. **atomaria** (Fisch. & Mey.) Chandler

N. atomaria Fisch. & Mey., Index Sem. Hort. Petrop., 2:42. 1835.
N. insignis var. *atomaria* Jepson, Fl. West. Mid. Calif., 434. 1901.
N. macrocarpa Eastwood, Bull. Torrey Club, 29:471. 1902.
N. Johnsoni Eastwood, *op. cit.*, p. 472.
N. Menziesii var. *atomaria* Chandler, Bot. Gaz., 34:204. 1902.
N. Menziesii subsp. *atomaria* Brand, Pflanzenr., IV. 251. 49. 1913.
N. Menziesii subsp. *atomaria* var. *eu-atomaria* Brand, *op. cit.*, p. 49.
N. Menziesii subsp. *atomaria* var. *macrocarpa* Brand, *op. cit.*, p. 50.
Viticella Menziesii var. *atomaria* Macbride, Contr. Gray Herb., 59:30. 1919.

Like the species, but herbage more definitely succulent and less hairy; corolla 1.5–3 cm. broad, white with black dots radiating from the center almost to periphery, and occasionally faintly suffused with blue or slightly venose, lobes usually narrower than in the species; corolla scales usually reduced to hairy lines; seeds 8–12.

Type locality.—"Circa coloniam Ross in Nova California" (Fort Ross, Sonoma County, California), no collector designated.

Range.—Western Santa Clara County, California, north to Washington County, Oregon, chiefly along the coast; Humid Transition zone, moist open places.

Specimens examined.—OREGON. Locality uncertain: "Southern Oregon" (1881), *T. Howell* (F, NY, US). Washington Co.: Forest Grove, *Henderson* 686 (F, M, OS, UO, WS), *Thompson* 554 (M, S, Thompson). Tillamook Co.:

Camas Valley, *Henderson* 15,350 (UO). Yamhill Co.: McMinnville, *Gorman* 7538 (PA, UO); Sheridan, *Thompson* 4121*a* (G, M, NY, P, PA, S, Thompson, US). Polk Co.: Independence, *Gorman* 4425 (PA, S, WS); West Salem, *J. C. Nelson* 2042 (G, WS). Marion Co.: Marion, *J. C. Nelson* 525 (S, WS), 4220 (OS, PA, WS); Salem, *Peck* 5749 (Wil). Lane Co.: Eugene (1925), *Constance* (UC); Jasper, *Henderson* 15,915 (UO); Springfield, *Bradshaw* 1313 (S). Douglas Co.: Elk Head (1881), *T. Howell* (UC, UO); Myrtle Creek, *Thompson* 10,180 (M, NY, P, S, Thompson); Roseburg (1891), *J. Howell* (PA, UO, WS); "Umpquaw River, Coos County" (1898), *A. J. Johnson* (CA: type of *N. Johnsoni*). Coos Co.: Coos Bay, *Sheldon* 11,743 (F, S, UO); South Fork of Coos River, *H. H. Smith* 3585 (F, NY, US). Curry Co.: Chetco River, *D. K. Kildale* 7006 (S); Port Orford, *Peck* 8465 (G, Wil). Josephine Co.: Applegate River, *Applegate* 4171 (F, S); Galice, *Henderson* 5964 (CA, M, RM, S, UO); Grants Pass (1887), *T. Howell* (OS, WS); Kerby, *N. P. Gale* 22 (M, S, Thompson); Selma, *Henderson* 5768 (CA, M, RM, S, UO). Jackson Co.: Applegate Valley, *Thompson* 2228 (Thompson).

CALIFORNIA. Del Norte Co.: Adams Station, *Eastwood* 15,067 (CA, F, UC); Crescent City, *Tracy* 12,025 (UC); Darlingtonia, *Parks & Parks* 24,113 (UC). Humboldt Co.: Grasshopper Peak, *Constance* 879 (Jepson, WS); Hupa Mountains, *Chandler* 1276 (P, S, UC, US); Hydesville, *Tracy* 2445 (F, G, M, NY, P, RM, S, UC, UO, US); Jarnagan (1890), *W. W. Price* (CA: type of *N. macrocarpa*); Little Van Duzen River, *Eastwood & Howell* 4803 (CA, F); Valley of Van Duzen River, *Tracy* 4094 (UC, US). Siskiyou Co.: Crapo Creek, *L. B. Kildale* 1706 (S). Trinity Co.: Island Mountain, *D. K. Kildale* 4534 (S); Weaverville, *Yates* 273 (UC). Mendocino Co.: Bell Springs (1902), *Davy* (UC); Mount Sanhedrin, *Bacigalupi* 1535 (S); Red Mountain, *Eastwood & Howell* 4645 (CA). Sonoma Co.: Bodega Bay, *Heller & Brown* 5181 (CU, F, G, M, NY, P, PA, RM, US); Cloverdale, *Bolander* 3883 (F, M, NY, UC, US); Fort Ross, *Heller* 6600 (CA, F, G, M, NY, P, PA, RM, S: topotypes of *N. atomaria*), *Constance* 2158; Sonoma Creek, *Heller & Brown* 5047 (CU, F, G, M, NY, P, PA, RM, US). Napa Co.: Napa Valley (1874–75), *Greene* (F, G); Palisade Mine, *J. T. Howell* 1742 (CA). Marin Co.: Corte Madera, *Bigelow* 42 (G, NY), *Parks & Parks* 0461 (CA, F, M, NY, P, S, UC, US); Fairfax (1891–92), *Michener & Bioletti* (S, UC, US); Mill Valley (1891), *Jepson* (NY, UC, US, WS); Point Reyes, *Abrams* 11,573 (NY, RM, S), *L. S. Rose* 35,025 (CA, F, M, UW); Tomales Bay, *Mason* 4268 (UC). San Mateo Co.: Colma, *Chandler* 800 (S, UC); Seal Cove (1900), *Dudley* (S). Santa Clara Co.: Black Mountain, *Abrams* 1534 (S); Loma Prieta Peak, *Davy* 441 (UC), *Elmer* 4666 (CA, M, NY, OS, P, S, UC, UO, US: isotypes of *N. Menziesii* f. *umbrosa*).

This is maintained as a distinct variety of *N. Menziesii* not so much because of any major morphological gap separating it from the species as because the entity has a relatively discrete geographical range and is almost "pure" Type I, at least in the northern part of its occurrence. Collections from the type locality at Fort Ross show a high variability of coloration (cf. Fig. C, 22–24), which firmly connects the variety with the species. The plants are a little more succulent and less pubescent than those typical of the species, perhaps a reflection of their frequently maritime habitat, but there is an abundance of atavistic exceptions, even to color, which prevents specific segregation. Dried collections are often difficult of exact disposition because

improper preservation will cause diffusion of color from the veins, making the corollas appear to be those of Type II and hence referable to typical *N. Menziesii.*

It is uncertain whether *N. macrocarpa* and *N. Menziesii* f. *umbrosa* belong here or are on the adjoining fringe of Type II of the species. Grain fields of western Oregon present a favorite habitat for var. *atomaria,* and it is quite probable that the plant is spread with grain seed, so that the natural limits of its distribution are difficult to determine.

6*b*. Nemophila Menziesii var. integrifolia Parish

N. diffusa Nutt. ex Hook., Jour. Bot. & Kew Miscel., 3:293. 1851, as a synonym of *N. parviflora* Dougl. ex Benth.
N. Menziesii var. *integrifolia* Parish, Erythea, 6:92. 1898.
N. rotata Eastwood, Bull. Torrey Club, 28:159. 1901.
N. Bakeri Eastwood ex C. F. Baker, West Amer. Plants, 3:9. 1904, nomen nudum.
N. Menziesii var. *rotata* Chandler, Bot. Gaz., 44:381. 1907.
N. Menziesii var. *annulata* Chandler, *op. cit.*, p. 44.
N. integrifolia Abrams, Fl. Los Angeles, 320. 1904.
N. Menziesii subsp. *australis* Brand, Pflanzenr., IV. 251. 50. 1913.
N. Menziesii subsp. *australis* var. *integrifolia* Brand, *op. cit.*, p. 50.
N. Menziesii subsp. *australis* var. *incana* Brand, *op. cit.*, p. 50.
N. Menziesii subsp. *australis* var. *annulata* Brand, *op. cit.*, p. 50.
N. Menziesii subsp. *australis* var. *minima* Brand, *op. cit.*, p. 50.
Viticella Menziesii var. *integrifolia* Macbride, Contr. Gray Herb., 59:30. 1919.
V. Menziesii var. *rotata* Macbride, *op. cit.*, p. 31.
Nemophila rotata var. *integrifolia* Munz & West ex Munz, Man. So. Calif. Bot., 404. 1935.
N. rotata var. *incana* Munz & West ex Munz, *op. cit.*, p. 404.
N. rotata var. *annulata* Munz & West ex Munz, *op. cit.*, p. 404.

Like the species, but usually more slender and becoming very diffuse; lower leaves with only 5–7 entire or few-toothed lobes, upper leaves entire or shallowly few-toothed, rhomboid, spatulate or oblong, sessile or nearly so and greatly reduced upward; corolla rotate or very shallow, pale or deep blue, punctate at the center with large black dots or blue-venose or with a deep blue periphery or with various combinations of these patterns, 0.6–1.5 cm. broad, lobes oblong to obovate, conspicuously exceeding the very short tube, whole corolla little exceeding calyx; corolla scales linear to triangular, attached at base and partly by one side, the free edge and tip hairy or laciniate; filaments exceeding corolla tube; mature capsule about equalled by moderately accrescent calyx; seeds 4–10.

Type locality.—"Open ground, head of Waterman Cañon, at 4,000 ft. alt. in the San Bernardino Mountains" (San Bernardino County, California), 1889, *S. B. Parish.*

Range.—Mountains of southern California and adjacent Baja California, southwest of the desert region to southern Santa Barbara and Ventura counties.

Specimens examined.—CALIFORNIA. Santa Barbara Co.: Zaca Cañon, *Abrams* 10,994 (S); Zaca Lake, *Eastwood* 568 (CA, Clokey). Ventura Co.: Foster Park, *Eastwood* 5008 (CA); Ventura (1922), *M. L. Kendall* (P). Los Angeles Co.: Claremont, *C. F. Baker* 5309 (CA, P, S); Deer Park, *J. T. Howell*

3770 (CA, NY, S); Elizabeth Lake, *H. M. Hall* 3081 (UC: type of *N. Menziesii* var. *incana,* M, NY, P, PA, RM, S, UO, US); Little Santa Anita Cañon, *Abrams* 2614 (G, M, NY, P, S, US); Mandeville Canyon, *Clokey & Templeton* 4454 (Clokey, CU, F, NY, P, UC, US); Pasadena, *M. E. Jones* 3037 (CA, Clokey, M, NY, P, PA, S, UC: isotypes of *N. Menziesii* var. *minima*); San Dimas, *Munz & Harwood* 3343 (P, RM, S, US); Swartout Valley (1931), *Epling, Dunn & Goen* (CA, F, M, OS, UC). San Bernardino Co.: Cajon Pass, *Peirson* 364 (Peirson, Jepson); Dark Cañon, *Munz, Street & Williams* 2819 (P, S, UC); Dead Man's Point, *Hall & Chandler* 6769 (UC: type of *N. Menziesii* var. *annulata,* F, G ,M, NY, P, PA, RM, S, UC, UO, US, UW); Hesperia, *Spencer* 569 (G, NY, P, US); Lake Arrowhead, *Axelrod* 291 (UC, VTM); San Bernardino, *Parish* 4196 (G, M, NY, US); San Bernardino Mountains (1879), *Lemmon* (F, G, M), *Parish & Parish* 57 (F, PA, S, US); San Bernardino Valley, *Parish* 5580 (F, G, M, NY, OS, P, PA, RM, S, UC, UO, US, UW); Sawpit Canyon, *Clokey & Anderson* 6837 (Clokey, F, NY, P); "Southern California," *Parry & Lemmon* 255 (F, G, M, NY, US); Waterman Canyon (1889), *Parish* (S: type of *N. Menziesii* var. *integrifolia,* UC). Riverside Co.: Elsinore, *C. F. Baker* 4123 (CA, F, G, M, NY, P, UC-part: basis for *N. Bakeri*); French Valley, *Hall* 1951 *& Jepson* 1537 (Jepson, S, UC); Fuller's Mills Mountains, *H. M. Hall* 2266 (S, UC, US); Gregg's Ranch, *Jaeger* 934 (P, US); Strawberry Valley, *Jepson & Hall* 1288 (Jepson, UC). Orange Co.: Santa Ana Cañon, *Peirson* 3495 (Peirson); Silverado Canyon, *Munz & Harwood* 3726 (P, US). San Diego Co.: Campo, *Abrams* 3609 (M, NY, P, S), *Eastwood* 9463 (CA, G, P), *Munz & Johnston* 12,634 (CU, F, M, P, S, UC); Fallbrook, *Abrams* 3319 (F, G, M, NY, P, PA, S, US); Lion's Valley, *Munz* 7968 (G, NY, P); Mesa Grande, *Spencer* 1167 (CA, CU, G, NY, P); Point Loma (1906), *K. Brandegee* (F, G, M, NY, P, PA, RM, S, UC, UO, US, UW), *Eastwood* 2547 (CA, Clokey, G, M, NY, P, US), *Wiegand & Upton* 4081 (CU, F); San Diego (1891), *Eastwood* (CA: type of *N. rotata*); "St. Diego," *Nuttall* (K, PA: basis for *N. diffusa*).

Baja California. Cantillas Mountains, *Orcutt* 1128 (CA, UC); Japa, *Orcutt* 1128 (G-part, M-part, UC, US-part); Mountains of northern Lower California (1885), *Orcutt* (M).

The diffuse, small-flowered plants comprising this variety have undergone a considerable diversity of treatment since the publication in 1889 of var. *integrifolia,* based upon material from the San Bernardino Mountains. Prior to that time, they had been referred either to *N. Menziesii* or to *N. parviflora,* depending solely upon the size of the corolla. There is, however, a much older name, which was intended for this entity but was mistakenly assigned elsewhere. Collections of this plant made by Nuttall at San Diego and labeled "N. diffusa" are mounted on the same sheet of Hooker's herbarium with a collection of Geyer's from Idaho. Hooker (1851, p. 293) referred Geyer's specimens to *N. parviflora* (although they are actually of the very different *N. breviflora*) and listed *N. diffusa* Nutt. as a synonym of *N. parviflora.* Eastwood took plants from San Diego, identical with those of Nuttall, as the type of *N. rotata,* which designates the small-flowered extreme of var. *integrifolia.* Although he had previously considered it a part of this variety, Chandler later (1907) accorded varietal rank to Eastwood's species and described as new var. *annulata* from the border of the Mohave Desert. Abrams used *N. integrifolia*

to include the small-flowered forms of *N. Menziesii* occurring in the vicinity of Los Angeles. The greatest amount of segregation was achieved by Brand, who (1913) kept *N. rotata* as a distinct species and combined the others of this group under *N. Menziesii* subsp. *australis,* which he credited with vars. *integrifolia, incana, annulata,* and *minima.* Macbride (1919, pp. 30–31) grouped the entire entity into *Viticella Menziesii* vars. *integrifolia* and *rotata.* Recently, Munz & West (1935, p. 404) have removed subsp. *australis* from *N. Menziesii* and combined it with *N. rotata* under the latter name, admitting vars. *integrifolia, incana,* and *annulata,* although they note the occurrence of "intergrades" between *N. Menziesii* and *N. rotata* as thus constituted.

Chandler's original disposition of this austral phase of *N. Menziesii* is, in my opinion, preferable to his later recommendations and to all the subsequent treatments. Although the types of some of the segregates come from very different altitudinal and environmental situations, the phases they represent appear to intermingle so thoroughly over much of their ranges as to make even varietal separation for them unsatisfactory. The characters which are supposed to distinguish them are almost entirely those of size and color of the corollas, and size, attachment, and pubescence of the corolla scales. These characters, it will be recognized, are precisely those which have proved notoriously unreliable for segregating species or varieties from typical *N. Menziesii.*

There is no sharp line of demarcation between the species and this variety, any more than there is between the species and var. *atomaria,* and the varieties must be separated by the possession of a certain combination of characters associated with a natural geographical distribution. For this reason, it would seem advisable to continue var. *integrifolia* as a subordinate population under *N. Menziesii* rather than to accord it specific rank as *N. rotata.* The large number of transitional forms between the species and var. *integrifolia* is to be expected as connecting incompletely separated units, but is scarcely to be anticipated as joining distinct species. This is the only species or variety of *Nemophila* native to the Pacific Coast, however, which I have not had the opportunity to collect and study in the field. Consequently, habital characters or others which are not apparent in dried material may have been unintentionally minimized.

7. Nemophila spatulata Coville

N. spatulata Coville, Contr. U. S. Nat. Herb., 4:156. 1893.
N. inconspicua Eastwood, Bull. Torrey Club, 28: 144, 1901, *non* Henderson, 1900.
N. humilis Eastwood, *op. cit.,* p. 150.
N. Congdoni Eastwood, *op. cit.,* p. 151.
N. pratensis Eastwood, Bull. Torrey Club, 29:474. 1902.
Viticella spatulata Macbride, Contr. Gray Herb., 59:32. 1919.
V. humilis Macbride, *op. cit.,* p. 32.

Stems weak, more or less succulent, obscurely angled, 1–3 dm. long, sparsely hispid or glabrate; blades of cotyledons oval, 5–9 mm. long, 1.5–5 mm. broad, tapering into a narrowly winged petiole of about equal length, withering

before completion of anthesis; leaves all opposite, the lowest oval to orbicular, obtuse, cuneate at base, about 1 cm. long, 1 cm. broad, pinnately, shallowly 3–5-lobed, divisions oblong or ovate, entire, obtuse, petioles exceeding blades, moderately winged, upper leaves spatulate to broadly cuneate, shallowly 3–5-toothed, teeth triangular-ovate and mostly entire, all loosely appressed- hir-

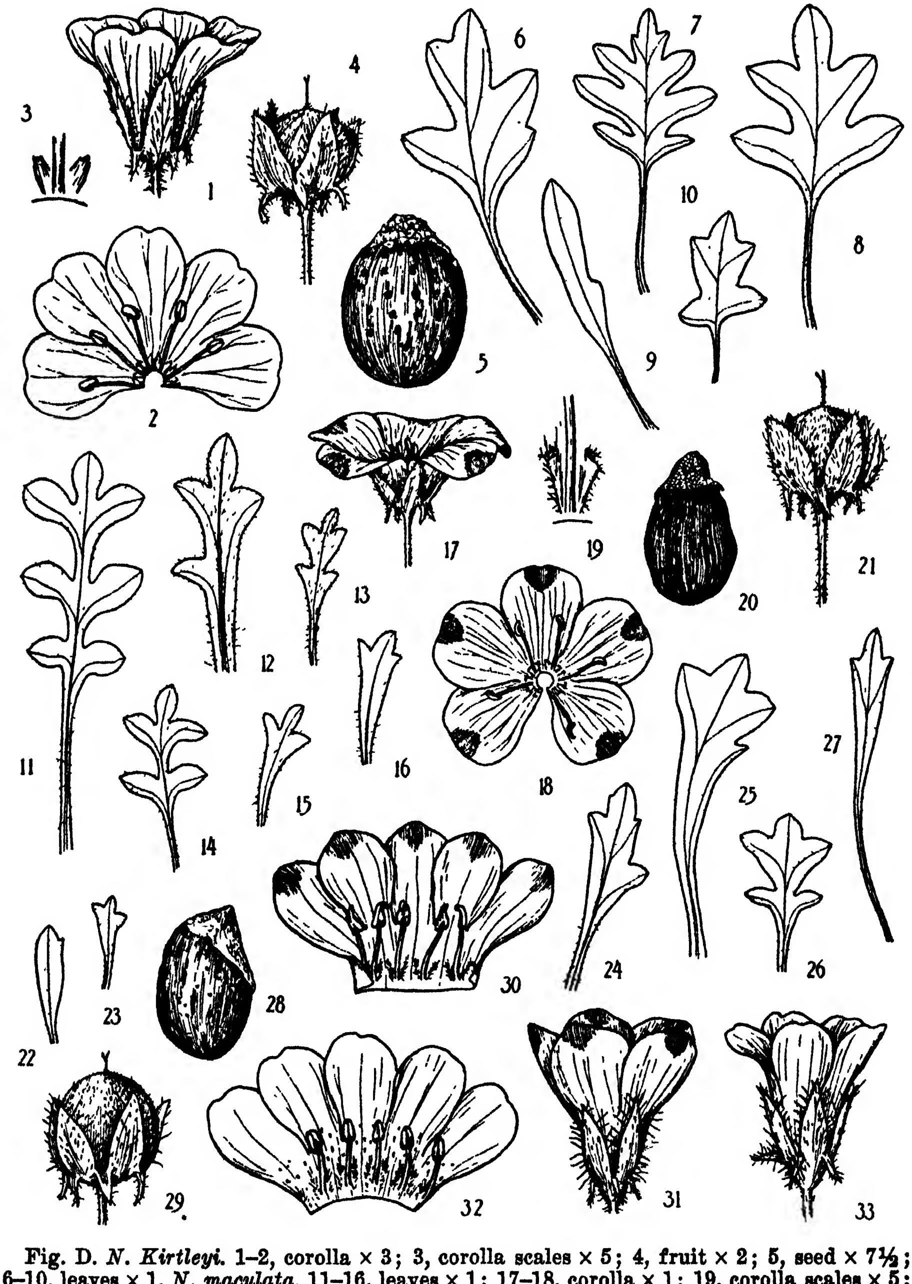


Fig. D. *N. Kirtleyi.* 1–2, corolla × 3; 3, corolla scales × 5; 4, fruit × 2; 5, seed × 7½; 6–10, leaves × 1. *N. maculata.* 11–16, leaves × 1; 17–18, corolla × 1; 19, corolla scales × 5; 20, seed × 7½; 21, fruit × 1. *N. spatulata.* 22–27, leaves × 1; 28, seed × 7½; 29, fruit × 4; 30–31, corolla, no. 2319, × 2½; 32–33, corolla, no. 2279, × 4.

sute or hispid, stomatiferous on both surfaces, rather thick and herbaceous in texture; flowers solitary in the axils on short pedicels; calyx broadly campanulate, lobes 2.5–5 mm. long, 1–2 mm. broad, acute, auricles reflexed, 1–1.5 mm. long; corolla pelviform, 0.5–1 cm. broad, white or bluish and centrally punctate or venose or with purple distal blotches, lobes oval, exceeding tube, obtuse or emarginate; corolla scales broad, free edge hairy, or narrower or reduced to hairy lines; filaments shorter than tube, anthers oblong, 0.5–1.5 mm. long; style 1 mm. long to almost 0, cleft only at apex; mature capsule 4–7 mm. in diameter, exceeding the weakly accrescent calyx; seeds usually 5–6, ovoid, 3 mm. long, light brown, smooth but shallowly pitted; cucullus usually papillaeform, deciduous.

Type locality.—"Whitney Meadows, Sierra Nevada, Tulare Co., Calif.," August 21, 1891, Death Valley Expedition, *F. V. Coville* 1671.

Range.—Sierra Nevada from Plumas County to Kern County, San Bernardino and San Jacinto mountains, and Mount Piños; high and middle altitudes in the Transition and Canadian zones.

Specimens examined.—NEVADA. Douglas Co.: Glenbrook (1928), *M. S. Jussel* (CA).

CALIFORNIA. Tehama Co.: Battle Creek Meadows (1927), *J. Grinnell* (Jepson-part). Plumas Co.: Chester, *Constance* 2319. Butte Co.: Jonesville (1930), *E. B. Copeland* (CA, CU, F, M, NY, P, RM, S, UC, UO, US); Chico Meadows, *Heller* 11,964 (CA, F, G, M, NY, OS, S, US); Butterfly Valley (1897), *Austin* (US); Mosquito Creek, *Heller* 13,177 (CA, CU, G, M, NY, S, US). Nevada Co.: Donner Lake (1903), *Heller* (G, UC); Soda Springs (1881), *M. E. Jones* (G, P). Placer Co.: Cisco, *Heller* 12,692 (F, G, M, NY, OS, S, US), *Constance* 2279; Emigrant Gap, *M. E. Jones* 2816 (CA, Clokey, M, NY, P, UC, US); Deer Park, *Eastwood* 374 (CA, M, NY, US); Summit (1898), Eastwood (CA: type of *N. humilis*). Eldorado Co.: Mount Tallac, *J. T. Howell* 1410 (CA); Fallen Leaf Lake (1921), *Ottley* (Jepson). Alpine Co.: Lake Alpine, *Peirson* 11,568 (UC). Amador Co.: Silver Lake,*Schreiber* 2403 (VTM). Tuolumne Co.: Hog Ranch, *Hall & Babcock* 3390 (P, RM, S, UC), *Mason* 2167 (UC); Aspen Valley, *L. Benson* 3762 (NY, S, UC, US); Mather, *Keck* 1228 (CA, P); Miguel Meadows, *Mason* 11,941 (UC); road to Hetch-Hetchy (1897), *Congdon* (CA, G); Tamarack Flat, *Mason* 11,959 (UC); Tioga Road (1896), *Congdon* (CA: type of *N. Congdoni*); Snow Flat (1902), *Eastwood* (G, NY). Mariposa Co.: Clark's (1883), *Meehan* (PA); Crane Flat, *Jepson* 10,439 (Jepson); Peregoy's (1872), *A. Gray* (G); Yosemite Falls, *Chandler & Babcock* 1086 (G, M, NY, RM, UC, US); Yosemite Valley, *Torrey* 244 (NY), *Chandler & Babcock* 1012 (CA, F, G, M, NY, P, RM, S, UC, UO, US). Madera Co.: Chilkoot Creek, *Constance* 2367; Cold Springs Meadow, *Constance* 2357; North Fork of Willow Creek, *Constance* 2371. Mono Co.: Reverse Creek, *Peirson* 6137 (P); Slate Creek, *Keck* 4986 (Keck). Fresno Co.: Bearskin Meadows (1899), *Eastwood* (CA: type of *N. pratensis*); Deer Creek, *Hall & Chandler* 423 (S, UC, UO); Mammoth Mill (1913), *T. S. Brandegee* (P, UC); Pine Ridge, *Hall & Chandler* 104 (M, NY, S, UC, US). Tulare Co.: Mineral King, *Coville & Funston* 1522 (US); Monache Meadows, *Hall & Babcock* 5292 (PA, RM, S, UC); Volcano Meadows, *Hall & Babcock* 5487 (CU, G, UC); Whitney Meadows, *Coville & Funston* 1671 (US: type of *N. spatulata*, UC). Kern Co.: Greenhorn Range, *Hall & Babcock* 5046 (PA, S, UC); Mount Piños, *Hall* 6395 (UC); Tehachapi Mountains, *Hasse & Davidson* 1717 (S-part, UC). San Bernardino Co.: Bluff Lake, *Munz* 10,433 (P, RM, UC, US);

Santa Ana River, *Peirson* 3119 (P). Riverside Co.: Tamarack Valley, *H. M. Hall* 2406 (M, NY, S, UC, US).

N. humilis was described from very small, erect plants whereas *N. Congdoni* was based upon the most diffuse form. Plants with narrower leaves and smaller flowers, a type which occurs with the broader-leaved and smaller-flowered forms north of Fresno County but which seems to supplant the latter to the south, have been designated *N. spatulata* and *N. pratensis*. The comparative length of the always short style has been used to separate *N. spatulata* from *N. humilis*, but my observations indicate that this character asserts itself independently of leaf and flower form, and does not lend itself to the division of actual geographical entities. Treated as a single species, *N. spatulata* is a very natural unit, occurring in the Sierra Nevada throughout their length, and occasionally in the ranges to the south. Its most common habitat is moist sand, on the edges of streams or meadows, either in the open or in light shade.

Habitally, *N. spatulata* shows variations closely similar to those of *N. pedunculata*, which often grows with it. The plants flower and fruit when they are less than a centimeter high and quite erect, but later become prostrate and diffuse. The size of the corolla is even more variable than it is in *N. pedunculata*, but the same series of color forms are found in both species. The presence of stomata upon both surfaces of the leaves, the shape of the leaves, and the markings of the corolla frequently suggest a relationship with *N. maculata*.

8. Nemophila maculata Benth. ex Lindl.

N. maculata Benth. ex Lindl., Jour. Hort. Soc. Lond., 3:319. 1848.
N. speciosa Hartweg ex Lindl., *op. cit.*, p. 319, as a synonym.
Viticella maculata Macbride, Contr. Gray Herb., 59: 30. 1919.

Stems somewhat succulent, angled or winged, 1–3 dm. long, loosely hispid or glabrate; blades of cotyledons oblong or oval, 0.8–1.5 cm. long, 2–4 mm. broad, tapering into a petiole shorter than blade, withering before completion of anthesis; leaves all opposite, lower oval or oblong with a cuneate base, 0.8–2 cm. long, 0.3–0.8 cm. broad, pinnately, deeply 5–9-lobed, lobes lanceolate to orbicular, entire or 1–3-toothed, petioles equalling or exceeding blades, upper leaves or all of them oblanceolate or spatulate, nearly sessile, apically 3-toothed to entire, all more or less hispid to hirsute and stomatiferous on both surfaces; flowers solitary in the axils on long, stout pedicels; calyx broadly campanulate, lobes lanceolate to triangular-ovate, 5–8 mm. long, 2–4 mm. broad, acute or obtuse, auricles reflexed, 1–4 mm. long; corolla pelviform to nearly rotate, 1.5–4.5 cm. broad, white and venose or punctate with a conspicuous purple spot at the apex of each lobe, lobes oblanceolate to obovate, entire or emarginate, exceeding tube; corolla scales oblong or linear, pubescent on free edge; filaments slightly exceeding tube, anthers oblong, 1.5–2.5 mm. long; style 3–6 mm. long, cleft about one-third; mature capsule 4–6 mm. in diameter, slightly exceeding calyx; seeds 5–12, ovoid, about 2 mm. in diameter, smooth or shallowly pitted; cucullus usually papillaeform, deciduous.

Type locality.—"Ad rivulos in montibus Sacramento" (western foothills

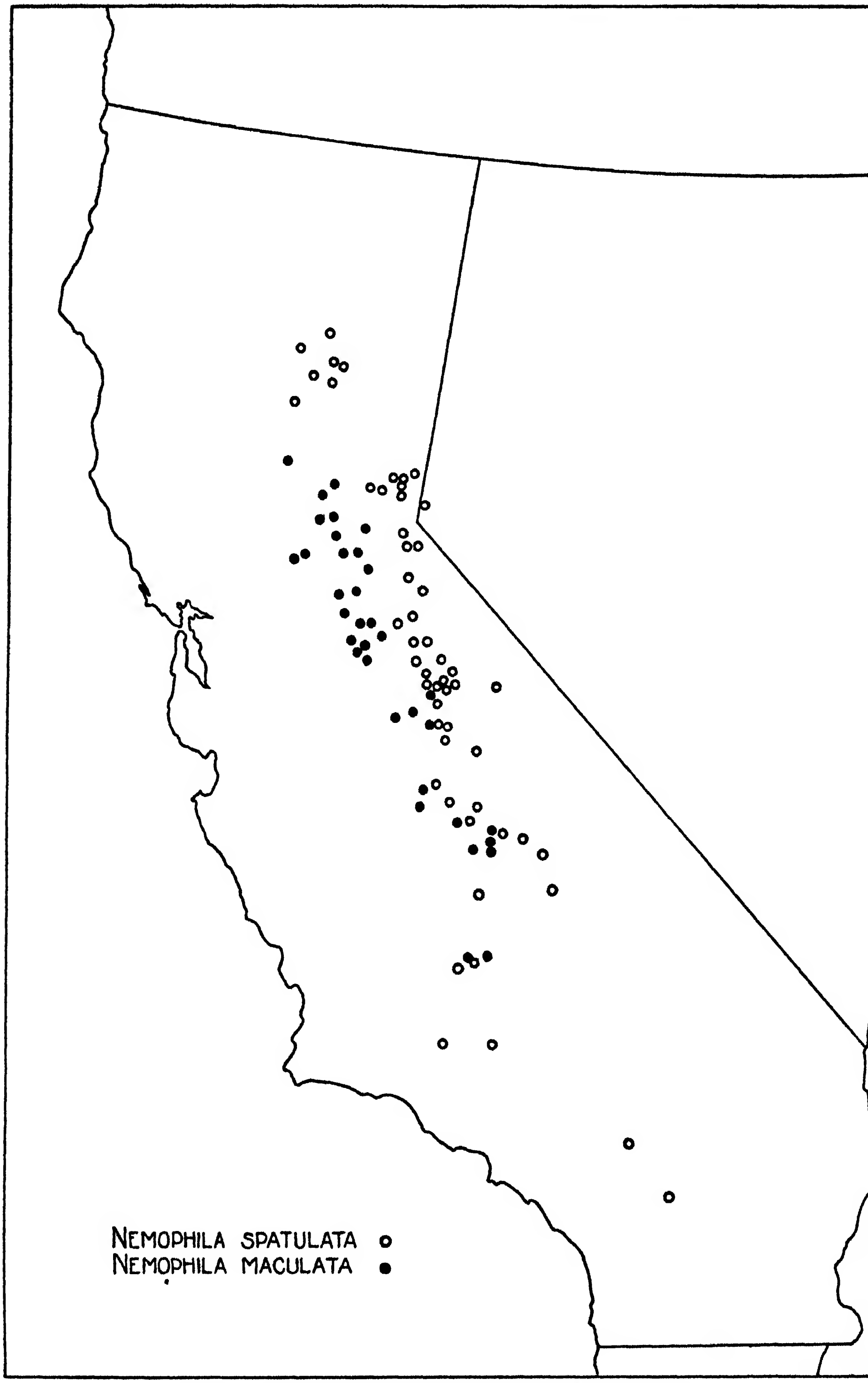
of the northern Sierra Nevada, presumably on the South Fork of the Yuba River, Sierra County, California), 1867, *Hartweg* 358.

Range.—Western foothills of the Sierra Nevada, from Plumas County to Kern County; chiefly Upper Sonoran and Transition zones, in moist meadows.

Specimens examined. — CALIFORNIA. Locality uncertain: "Sacramento Mountains," *Hartweg* 358 (K: type of *N. maculata,* G, US); "Valley of the San Joaquin," *Fremont* 231 (K, NY). Plumas Co.: (1876), *Austin* (F); English Colony (1895), *Ames* (UC). Butte Co.: Forbestown, *E. Brooks* (UC). Nevada Co.: Nevada City (1913), *Coombs* (CA, G, US); Penn Valley, *Jepson* 15,090 (Jepson). Yuba Co.: Los Vergils, *Eastwood* 10,570 (CA). Placer Co.: Auburn (1878), *Ames* (G); Grizzly Bear House, *Bolander* 4551 (M, UC, US); New Castle, *Bolander* 4566 (CU, M, UC, US). Eldorado Co.: Big Cañon, *Jepson* 18,623 (Jepson); Clarksville–Shingle Springs, *Heller* 11,286 (CA, Clokey, CU, F, G, M, NY, OS, PA, S, US); Greene Valley, *Mason* 4508 (UC); Lotus, *Jepson* 18,603 (Jepson); Kelsey, *M. E. Jones* (Clokey, M, NY, P, US); Pilot Hill, *Bracelin* 230 (UC). Sacramento Co.: Sacramento (1898), *A. King* (Jepson). Amador Co.: Agricultural Station, Clinton, *Hansen* 88 (M, OS, S, UC, US); Panther Creek, *Hansen* 1154 (M, S); Pioneer, *Hansen* 2056 (K, M, S, US). Calaveras Co.: Angels Camp, *Mason* 11,053 (UC); Big Trees, *Brewer* 2098 (NY, UC); Calaveras Grove, *Lemmon* (G, UC), *Mason* 3345 (UC). Tuolumne Co.: Duffield's Ranch, *Bigelow* 38 (G, NY, PA, US); French Flat, *Ferris* 1537 (CA, Clokey, NY, S, US); Long Barn, *Hoover* 2529 (Hoover). Mariposa Co.: Blochman's Ranch, *Eastwood* 4277 (CA); Pea Ridge Road (1901–3), *Congdon* (M, US); Yosemite Valley, *Chandler & Babcock* 1010 (UC). Madera Co.: Oakhurst, *Eastwood & Howell* 5385 (CA, UO). Fresno Co.: Big Sandy Creek (1915), *J. McDonald* (CA, S); Pinehurst, *Ottley* 1387 (CU); Pine Ridge, *Hall & Chandler* 167 (S). Tulare Co.: Alta Meadows (1905), *K. Brandegee* (UC, US); Bear Creek, *Purpus* 1732 (UC); Kaweah River Valley, *Coville & Funston* 1338 (US); Mineral King (1892), *T. S. Brandegee* (UC, US). Kern Co.: Greenhorn Pass, *Purpus* 5203 (UC); Greenhorn Peak, *L. Benson* 3650 (S, Thompson); Greenhorn Range, *Hall & Babcock* 5034 (CU, G, S, US), *Peirson* 8866 (P, Peirson).

This species is a conspicuous and characteristic inhabitant of the lower elevations of the western slope of the Sierra Nevada. At higher altitudes it becomes more diffuse in habit, the leaves are less divided to entire, and the flowers are greatly reduced. There is much variation in the amount and distribution of violet markings on the white corolla. It is worth noting that the only distinguishing feature usually attributed to *N. maculata,* the presence of a distal purple blotch upon each corolla lobe, is not an exclusive possession of this species, but also occurs somewhat sporadically in both *N. spatulata* and *N. pedunculata.*

Because of its equally large corolla, this species is usually placed as though it were closely related to *N. Menziesii,* the two being separated in keys chiefly by color. Several other good distinctions exist, however, which have not been drawn into general use. The seeds of *N. maculata* are a rather light brown and smooth or shallowly pitted, while those of *N. Menziesii* are nearly black and strongly corrugate-tuberculate. Stomata occur upon both surfaces of the leaves in *N. maculata,* but are confined to the lower surface in *N. Menziesii.*



Map 5. Distribution of *N. maculata* and *N. spatulata.*

These characters clearly demonstrate that the collection from which *N. maculata* var. *concolor* was described is not a color form of that species, but actually belongs to *N. Menziesii.* This fact destroys the supposed evidence for the occurrence of hybridization between these two quite distinct species. The only other species whose leaves are bifacially stomatiferous is *N. spatulata,* whose relationship to *N. maculata* appears, upon this and other grounds, to be very close. Convenient distinctions are that *N. maculata* has much larger and shallower corollas and that it usually blooms much earlier and generally at a lower altitude.

9. **Nemophila parviflora** Dougl. ex Benth.

N. parviflora Dougl. ex Benth., Trans. Linn. Soc., 17:275. 1837.
N. macrophylla Eastwood, Bull. Torrey Club, 28:144. 1901.
N. pustulata Eastwood, *op. cit.,* p. 145.
N. micrantha Eastwood, *op. cit.,* p. 146.
N. Kelloggii Eastwood, *op. cit.,* p. 147.
N. Plaskettii Eastwood, *op cit.,* p. 147.
N. parviflora var. *typica* Brand, Pflanzenr., IV. 251. 54. 1913.
N. parviflora var. *typica* subvar. *Plaskettii* Brand, *op. cit.,* p. 54.
N. parviflora var. *typica* subvar. *macrophylla* Brand, *op. cit.,* p. 55.
Viticella parviflora Macbride, Contr. Gray Herb., 59:32. 1919.
V. parviflora var. *Plaskettii* Macbride, *op. cit.,* p. 32.

Stems weak, rather succulent and brittle, angled, 0.5–6 dm. long, densely hispid to glabrate; blades of cotyledons orbicular or oval, 0.6–1.2 cm. long, 0.5–1 cm. broad, ending abruptly in a petiole of about equal length, withering before completion of anthesis; lower leaves opposite, the upper alternate, lower ovate to orbicular, 1–4 cm. long, 1–3 cm. broad, obtuse or acute, truncate or cordate at base, pinnately parted into usually 5 oblong or ovate, acute or obtuse lobes, these entire or again incisely toothed or lobed, the 2 lower often distinct and sometimes petiolulate, the 3 upper confluent, or all more or less distinct but with narrow sinuses, petioles about equalling blades, uppermost leaves often sessile, asymmetrical and shallowly lobed or toothed, all appressed-hispid with often pustulate hairs, stomatiferous only below, thin and venose in texture; flowers solitary in axils, or opposite the alternate leaves, on short, slender pedicels; calyx campanulate, lobes oblong- or ovate-lanceolate, acute, 1–3 mm. long, 0.5–1.5 mm. broad, auricles 0.7–1 mm. long, reflexed; corolla campanulate, white or bluish, 2–4 mm. broad, lobes oval or obovate, about equalling tube, often emarginate and pilose distally, whole corolla exceeding calyx; corolla scales linear, free edge ciliate, or reduced to hairy lines or obsolete; filaments shorter than tube, anthers ovate, about 0.2 mm. long; style 0.8–1.2 mm. long, cleft about one-half; mature capsule 3–5 mm. in diameter, exceeding calyx; seeds usually 2–4, ovoid, 2–2.5 mm. long, yellow to brick-red, smooth but shallowly pitted; cucullus often papillaeform, deciduous.

Type locality.—"From the Columbia" (Fort Vancouver, Clark County, Washington), 1825, *Douglas.*

Range.—Monterey County, California, north to southern Vancouver Island, along the coast and inland to the Cascade Range in Oregon and Washington; forests of the Humid Transition zone.

Specimens examined.—BRITISH COLUMBIA. Alberni, *Rosendahl* 1963 (G, M, NY, US), *W. R. Carter* 97 (BC, G); Discovery Bay (1920), *Eastwood* (CA, G); Lost Lake (1887), *Macoun* (NY, US); Quarantine Lake, *McCabe* 5742 (UC); Skirt Mountain, *Macoun* 78,665 (F, UC); Vancouver Island (1858), *Lyall* (G-part); Victoria, *Macoun* 666 (F, M), 667 (CA: type of *N. pustulata*).

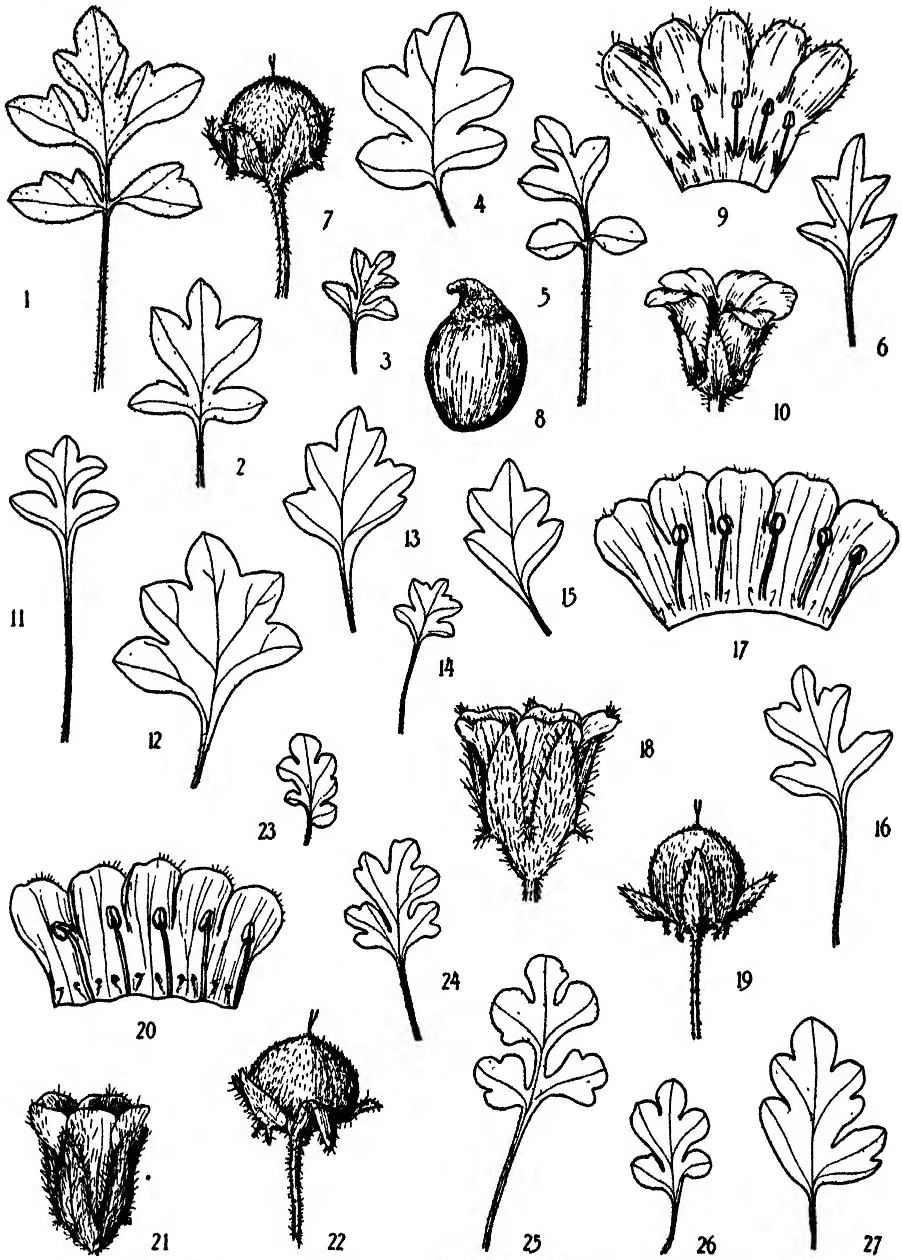


Fig. E. *N. parviflora.* 1–6, leaves × 1; 7, fruit × 4; 8, seed × 7½; 9–10, corolla × 5. Var. *Austinae.* 11–16, leaves × 1; 17–18, corolla, no. 2333, × 10; 19, fruit × 4. Var. *quercifolia,* 20–21, corolla × 5; 22, fruit × 4; 23–27, leaves × 1.

WASHINGTON. Locality uncertain: "N. W. Am.," *Scouler* (K); "Woods near Puget Sound," *Cooper* (G, NY, US). Skagit Co.: Anacortes, *C. L. Hitchcock* 3458 (UC, UW); Pleasant Ridge, *Mason* 5297 (UC). Whatcom Co.: Church Mountain, *Muenscher & Muenscher* 6038 (CU, UC); Lake Padden, *Muenscher & Muenscher* 5501 (CU). Snohomish Co.: Marysville (1926), *J. M. Grant* (RM); Everett (1924), *J. M. Grant* (RM). Island Co.: Camano Island (1895), *Gardner* (UC); Whidby Island, *Gardner* 395 (WS). San Juan Co.: Friday Harbor, *Cowles* 292 (F, M), *Zeller & Zeller* 875 (G, M, NY); Stuart Island, *Lawrence* 139 (WS). Clallam Co.: Olympic Mountains, *Elmer* 2830 (M, NY, P, S, UO, WS); Sequim, *J. M. Grant* 165 (G, WS), 530 (M, NY, US). Jefferson Co.: Constance Ridge, *Thompson* 6573 (M, Thompson); Elwha River, *H. E. Bailey* 38 (UC). Grays Harbor Co.: Elma (1920), *J. M. Grant* (PA); Montesano, *J. M. Grant* 847 (NY, S, UC, WS). Thurston Co.: Nisqually, *Pickering* 90 (US); Tumwater (1905), *E. C. Townsend* (WS). King Co.: Fort Lawton, *Eastwood* 9598 (CA, G); Seattle, *Thompson* 5966 (G, M, OS, PA, S, Thompson, US). Pierce Co.: Ashford, *Cowles* 631 (F, M); Lakeview, *L. Benson* 1207 (M, S); Upper Valley of Nisqually, *O. D. Allen* 61 (CU, F, G, M, NY, P, S, UC, US, WS). Cowlitz Co.: Kalama, *Thompson* 10,112 (CA, M, NY, P, S, Thompson); Kelso, *C. L. Hitchcock* 3274 (UC, UW). Pacific Co.: Fort Columbia, *Suksdorf* 6750 (WS). Clark Co.: Fort Vancouver (1825), *Douglas* (K: type of *N. parviflora*); Lake River, *Suksdorf* 3517 (WS). Skamania Co.: Little White Salmon River, *Suksdorf* 3567 (WS); Prindle, *Suksdorf* 7470 (CA, WS). Klickitat Co.: Bingen (White Salmon), *Suksdorf* 172 (UC, WS); Falcon Valley, *Suksdorf* 7225 (CA, G, M, NY, PA, S, Thompson, UC, US, WS); "W. Klickitat Co." (1881), *Suksdorf* (F, US).

OREGON. Locality uncertain: "Columbia" (1828), *Scouler* (K, NY); "Columbia River," *Nuttall* (K, PA); "Oregon," *Nuttall* (K); "Western Oregon" (1880–1), *T. Howell* (F, NY, S, UO, US). Hood River Co.: Hood River, *Henderson* 473 (M, UO, WS). Multnomah Co.: Bybie Slough, *Sheldon* 11,970 (S, UC); Mount Scott, *Sheldon* 12,276 (S, UO); Portland (1869), *Harford & Dunn* (G, NY, US), (1882), *Henderson* (OS, S); Sauvies Island (1876), *J. Howell* (F, P, WS), (1893), *T. Howell* (RM, S, UO). Columbia Co.: Clatskanie Creek, *Thompson* 2427 (Thompson); Saint Helens, *Suksdorf* 360 (WS). Clackamas Co.: Elk Rock, *Heller* 10,058 (F, US); Linnton, *Suksdorf* 1814 (CA, WS). Washington Co.: David's Hill, *Thompson* 555 (M, S); Scroggins Valley, *Thompson* 4296 (M, P, PA, S, US). Polk Co.: (1894), *Spillman* (WS); Falls City, *J. C. Nelson* 50 (S). Marion Co.: Salem, *E. Hall* 412 (F, G), *Peck* 5751 (Wil), *J. C. Nelson* 1119 (G). Benton Co.: Corvallis, *Jackson & Owen* 223 (S); Mary's Peak (1918), *Gilkey* (OS). Lane Co.: Coburg (1928), *Constance* (UC); Grasshopper Mountain, *Coville & Applegate* 1012 (US); Oakridge, *Constance, Henderson & Rollins* 1474 (Thompson, WS). Douglas Co.: Cow Creek Canyon, *Gorman* 5630 (PA, WS); Glendale, *Henderson* 1250 (UO). Coos Co.: Fat Elk Creek, *Constance & Beetle* 2628; Ross' Slough, *H. H. Smith* 3682 (F, NY). Curry Co.: McGribble's Ranger Station, *Peck* 8639 (Wil); Snow Camp, *Leach & Leach* 2337 (UO). Josephine Co.: Deer Creek, *Henderson* 5767 (CA, M, RM, S, UO), 5965 (CA, M, RM, S, UO); Grants Pass (1912), *H. S. Prescott* (S, Wil). Jackson Co.: Neil Creek, *Applegate* 2182 (S, US); Siskiyou Mountains, *Leiberg* 4022 (US); Wimer, *E. W. Hammond* 289 (NY, US).

CALIFORNIA. Locality uncertain: "California," *Menzies* (K). Del Norte Co.: Crescent City, *Tracy* 12,028 (UC); Little Mill Creek, *Parks & Parks* 5643 (UC); Patricks Creek, *Eastwood & Howell* 1344 (CA). Siskiyou Co.: Shasta

Springs, *Eastwood* 11,832 (CA); Upper Soda Springs, *Heller* 7925 (F, G, M, NY, PA, S, US). Shasta Co.: Big Bend (1923), *E. Bethel* (CA). Humboldt Co.: Bridgeville, *Eastwood & Howell* 4817 (CA, F); Look Prairie, *Constance* 606 (Jepson, WS); Willow Creek, *Tracy* 3321 (UC, US). Trinity Co.: Salyer, *Tracy* 14,922 (Jepson, S, UC); Union & Coffee creeks, *H. M. Hall* 8554 (F, G, M, NY, P, RM, S, UC, UO, US); South Fork Mountain, *Jepson* 16,665 (Jepson). Mendocino Co.: Cahto, *Jepson* 1849 (Jepson); Mendocino, *H. E. Brown* 742 (F, M, NY, US); Navarro River, *Constance* 2509; South Mill Creek, *Abrams* 6936 (Clokey, NY, PA, S, US). Sonoma Co.: Fort Ross, *Heller* 6611 (CA, F, G, M, NY, P, PA, RM, S, UC, US), *Constance* 2159; Russian Gulch, *Constance* 2153; Searsville, *Bolander* 21 (G, M). Lake Co.: Bartlett Mountain, *Abrams* 12,414 (NY, S); Bartlett Springs, *Mason* 11,746 (UC); Mount Sanhedrin (1902), *Heller* (CA). Napa Co.: White Sulphur Springs, *Chandler* 7569 (F, G, M, NY, P, PA, RM, S, UC, UO, UW). Glenn Co.: Bennett Spring, *Heller* 11,983 (CA, Clokey, CU, F, G, M, NY, OS, PA, S, US). Marin Co.: Mill Valley (1908), *Gardner* (F, G, M, NY, OS, P, PA, RM, S, UC, US, UW); Mount Tamalpais (1898), *Eastwood* (CA: type of *N. micrantha*); Ross Station (1901), *Eastwood* (M, NY, RM, S, UC, US). San Francisco Co.: San Francisco (1866), *Kellogg* (US); Sutro Woods, *K. Brandegee* (UC). San Mateo Co.: Crystal Springs Lake, *Constance* 2241; La Honda, *C. F. Baker* 509 (CA, G, M, NY, P, UC, US). Santa Clara Co.: Alma, *Heller* 7843 (F, G, M, NY, PA, US); Loma Prieta, *Davy* 532 (UC); Wrights, *Elmer* 4454 (CA, M, NY, P, S, UO, US). Santa Cruz Co.: Santa Cruz, *C. I. Anderson* 1 (G, M, PA); Santa Cruz Mountains (1876), *Kellogg & McLean* (CA: type of *N. Kelloggii*); Soquel Creek, *Jepson* 15,091 (Jepson). Monterey Co.: Cone Peak Trail, *A. Carter* 1063 (UC); Sur River (1893), *Eastwood* (CA: type of *N. macrophylla*); Tassajara Hot Springs, *Elmer* 3209 (M, S, US); Willow Creek, *Plaskett* 32 (CA: type of *N. Plaskettii*, G, NY).

This specific name has served as a general repository for any small-flowered species of the genus. In the classical collections of the Royal Botanic Gardens, for example, there occur on sheets labeled "N. parviflora" all of the following distinct entities: *N. breviflora, N. heterophylla, N. microcalyx,* and *N. Menziesii* var. *integrifolia;* other herbaria not infrequently add *N. pedunculata* and *N. spatulata* to this list, not to mention *Polemonium micranthum* Benth.! It is, then, small wonder that Miss Eastwood was moved to protest vigorously and to call attention to the fact that *N. parviflora,* as it had been misunderstood by many writers, was a largely unnatural aggregate of several distinct species and varieties.

N. parviflora is a common inhabitant of the humid coastal forests of the Pacific Northwest and the northern and central California coast. All references in past or current literature to this species as occurring east of the Cascade–Sierran axis, or south of Monterey County, are apparently due to erroneous identifications. A great variability in leaf form is exhibited, but this usually consists of modifications on a clearly apparent and constant basic pattern, and the species appears to remain quite uniform otherwise. In the southern Coast Ranges of California, however, it is exceedingly difficult to distinguish *N. parviflora* from a short-styled, short-flowered phase of *N. heterophylla.* The character of leaf form, in this instance, appears to be more relia-

ble than floral morphology in distinguishing the two species. The plants described as *N. macrophylla* and *N. Plaskettii,* respectively, both collected in Monterey County, stand very near the common boundary separating *N. parviflora* from *N. heterophylla.* In addition to the close resemblance to its two varieties, *N. parviflora* seems to be related directly only to *N. heterophylla,* as indicated above.

9a. Nemophila parviflora var. Austinae (Eastw.) Brand

N. inconspicua Henderson, Bull. Torrey Club, 27:349. 1900.
N. Austinae Eastwood, Bull. Torrey Club, 28:143. 1901.
N. explicata Nelson & Macbride, Bot. Gaz., 55:377. 1913.
N. parviflora var. *Austinae* Brand, Pflanzenr., IV. 251. 55. 1913.
N. parviflora var. *typica* subvar. *inconspicua* Brand, *op. cit.,* p. 55.
Viticella parviflora var. *Austinae* Macbride, Contr. Gray Herb., 59:32. 1919.

Like the species, but stems obscurely angled, 0.5–3 dm. long, sparsely hispid or glabrate; leaves apparently all opposite, lower orbicular, obtuse, broadly cuneate at base, 1–1.5 cm. long, 2–2.5 cm. broad, pinnately, shallowly lobed into 5–7 oblong or oval, obtuse, entire divisions, sinuses narrow, upper leaves short-petioled, narrow and shallowly lobed with triangular-ovate teeth, often asymmetrical at base, all finely appressed-hispid; calyx lobes lanceolate, auricles 0.2–0.4 mm. long; corolla 1.5–3 mm. broad, lobes obovate, equalling or slightly shorter than tube, whole corolla barely exceeding calyx; style 0.6–0.8 mm. long; corolla scales small and narrow, apex free and fimbriate, or reduced to hairy lines or obsolete.

Type locality.—"On Davis Creek, under trees" (Modoc County, California), June, 1885, *Mrs. R. M. Austin.*

Range.—Great Basin, from northeastern California and Utah to southeastern Washington and Idaho; coniferous woods of the Transition and Canadian zones.

Specimens examined.—IDAHO. Blaine Co.: Soldier Mountain, *Henderson* 3289 (US: type of *N. inconspicua*). Owyhee Co.: Silver City, *Macbride* 997 (F, G, M, NY, P, RM, S, UC, US, WS). Adams Co.: Starkey, *R. J. Davis* 800 (UC). Washington Co.: Deer Lake, *M. E. Jones* 6463 (P); Mann Creek, *Christ* 9298 (UC).

WASHINGTON. Asotin Co.: Anatone Butte, *F. G. Meyer* 424 (Thompson, WS-part). Klickitat Co.: Bickelton, *M. E. Jones* 25,565 (CA, M, P, S); Falcon Valley, *Suksdorf* 6587 (CA, WS), 7224 (CA, G, M, NY, PA, S, Thompson, UC, US, WS), 10,857 (CA, G, M, NY, PA, S, Thompson, UC, US, WS).

OREGON. Baker Co.: Baker City (1902), *M. E. Jones* (P). Union Co.: *Cusick* 872 (F-part, PA-part, UO), 3257*d* (UO); Little Eagle Bridge, *J. L. Peterson* 40 (USF6). Grant Co.: Dixie Butte, *Coville* 536 (US). Crook Co.: Cabin Station, *Ingram B*185 (USF6); Cougar Peak, *Coville & Leiberg* 172 (US). Harney Co.: Sawtooth Creek, *Henderson* 8697 (CA-part, UO). Lake Co.: Bullard Cañon, *Eggleston* 6923 (NY, US); Drew Valley, *Leiberg* 2784 (UO). Klamath Co.: Klamath Falls, *Applegate* 3488 (F, S); Skillethandle, *Applegate* 504 (S); Swan Lake Valley, *Applegate* 357 (G, S, US). Josephine Co.: Low Gap Trail, *Peck* 16,472 (NY, Wil); Siskiyou Mountains, *Heller* 13,628 (F, M, NY, S, US). Jackson Co.: Siskiyou Camp, *Henderson* 15,165 (UO).

UTAH. Weber Co.: Little Bear River Canyon, *Maguire* 16,371 (UC).

NEVADA. Elko Co.: Jarbidge, *Nelson & Macbride* 2229 (RM: type of *N. ex-*

plicata, G, M, NY, US). Washoe Co.: Alum Creek, *Heller* 9747 (CA, P, S, UC); Hunter Creek Canyon, *Kennedy* 1657 (CU, M, NY, PA, S, UC, US); Reno (1897), *M. E. Jones* (P). Douglas Co.: Glenbrook (1928), *M. S. Jussel* (CA).

CALIFORNIA. Modoc Co.: Davis Creek (1885), Austin (CA-part: type of *N. Austinae*); Thombs Creek, *Constance* 2333; Twelve Mile Creek, *Manning* (UC). Siskiyou Co.: Marble Mountain, *Chandler* 1649 (P, RM, S, UC, US), 1706 (S, UC); Mount Eddy, *Heller* 13,257 (CA, F, G, M, NY, PA, S, US); Quartz Valley, *Butler* 1231 (P, RM, S, UC, US); Upper Soda Springs, *Heller* 7925 (F, S). Lassen Co.: Fredonyer Pass, *Constance* 2324; Susanville (1892), *T. S. Brandegee* (UC). Plumas Co.: Greenville, *Eastwood* 14,471 (CA); Prattville, *Hall & Babcock* 4421 (S, UC), *Constance* 2318; Quincy, *Austin* 1091 (G, US). Sierra Co.: Yuba Pass, *Constance* 2304.

This variant of *N. parviflora* is less striking in its morphological dissimilarity to the species than in its separate geographical distribution. The distinctions are chiefly those of position, shape, lobing, and pubescence of the leaves, but the occurrence of a Great Basin variety of a coastal species is noteworthy. The variety and the species appear to intergrade, as far as is known, at only two points, (1) the Columbia River gap and (2) the Klamath gap, both of which disrupt the continuity of the Cascade-Sierran barrier.

Henderson's *N. inconspicua* is prior to *N. Austinae,* but Brand first adopted the latter in varietal combination. A word must be said about Chandler's (1902) reduction of this variety to synonymy under *N. pedunculata,* an error which was corrected by Brand (1913). The type specimen of *N. Austinae* is a mixture of that entity and of *N. pedunculata.* The two elements are so closely intermingled on the type sheet that one receives the impression of *N. pedunculata* leaves springing from stems of var. *Austinae.*

There is a suggestion of affinity between this variety and *N. Kirtleyi,* but this suggestion may be due only to similarity in leaf form. The supposed relationship with *N. pedunculata* does not appear to be at all close.

9*b*. Nemophila parviflora var. quercifolia (Eastw.) Chandler

N. quercifolia Eastwood, Bull. Torrey Club, 28:142. 1901.

N. parviflora var. *quercifolia* Chandler, Bot. Gaz., 34:210. 1902.

Stems densely villous or pilose; leaves apparently all opposite, ovate or orbicular, cordate or truncate at base, crenately lobed into 5–7 orbicular or obovate, rounded lobes, sinuses narrow, entire or few-toothed, lower leaves with 2 lowest divisions occasionally nearly distinct, the others confluent, upper leaves short-petioled, all rather densely villous; calyx lobes broadly lanceolate, acutish, auricles 0.5–0.8 mm. long; corolla 3–5 mm. broad, lobes equalling or shorter than tube; corolla scales usually narrow and glabrous; filaments about equalling tube; mature capsule 4–6 mm. in diameter; cucullus shallow or papillaeform, deciduous.

Type locality.—"Comstocks, near Sequoia Mills" (Fresno County, California), July 24, 1892, *Alice Eastwood.*

Range.—Western slope of the southern Sierra Nevada; growing in shade in the Transition Zone.

Specimens examined.—CALIFORNIA. Madera Co.: Chilkoot Creek, *Constance* 2366; Whiskey Creek, *Constance* 2384. Fresno Co.: Pine Ridge, *Hall & Chandler* 250 (M, NY, PA, S, UC, US); Sequoia Mills (1892), *Eastwood* (CA: type of *N. quercifolia*). Tulare Co.: Kaweah, *Hopping* 293 (UC); Limekiln Creek, *Jepson* 2798 (Jepson). Kern Co.: Green Horn Mountains, *Palmer* 32 (K, NY, US); Greenhorn Range, *Peirson* 8862 (P, Peirson), *Hall & Babcock* 5029 (PA, RM, S, UC), *J. T. Howell* 5085 (CA); Kernville (1871), *T. S. Brandegee* (UC).

This variety was confused with the preceding by Macbride (1919) because of its rather similar leaf form. It is, however, about equally distinct from both typical *N. parviflora* and var. *Austinae*, and its range is quite separate from that of either. The very obtuse lobes and the villous pubescence of the leaves clearly set it apart, but the floral unanimity of all three prevents their division into separate species. Like *Eriophyllum lanatum* vars. *arachnoideum* (F. & L.) Jepson and *croceum* (Greene) Jepson, *N. parviflora* and var. *quercifolia* constitute a closely related pair of plants, with one member in the coastal Humid Transition zone and the other in the Sierran Transition.

10. Nemophila heterophylla Fisch. & Mey.

N. heterophylla Fisch. & Mey., Sert. Petrop., t. 8. 1846.
N. exilis Eastwood, Bull. Torrey Club, 28: 148. 1901.
N. flaccida Eastwood, *op. cit.*, p. 149.
N. inaequalis Eastwood, *op. cit.*, p. 149.
N. hispida Eastwood, *op. cit.*, p. 152.
N. divaricata Eastwood, *op. cit.*, p. 153.
N. tenera Eastwood, *op. cit.*, p. 153.
N. nemorensis Eastwood, *op. cit.*, p. 155.
N. fallax Eastwood, *op. cit.*, p. 156.
N. glauca Eastwood, *op. cit.*, p. 156.
N. decumbens Eastwood, Bull. Torrey Club, 29:473. 1902.
N. diversifolia Eastwood, *op. cit.*, p. 473.
N. heterophylla var. *eu-heterophylla* Brand, Univ. Calif. Publ. Bot., 4:212. 1912.
N. heterophylla var. *eu-heterophylla* subvar. *divaricata* Brand, *op. cit.*, p. 212.
N. heterophylla var. *eu-heterophylla* subvar. *tenera* Brand, *op. cit.*, p. 212.
N. heterophylla var. *flaccida* Brand, *op. cit.*, p. 212.
N. nemorensis var. *glauca* Brand, *op. cit.*, p. 212.
N. nemorensis var. *typica* Brand, *op. cit.*, p. 212.
N. heterophylla var. *tenera* Nelson & Macbride, Bot. Gaz., 65:66. 1918.
Viticella exilis Macbride, Contr. Gray Herb., 59:31. 1919.
V. heterophylla Macbride, *op. cit.*, p. 31.
V. heterophylla var. *flaccida* Macbride, *op. cit.*, p. 31.
V. heterophylla var. *tenera* Macbride, *op. cit.*, p. 31.
Nemophila heterophylla var. *nemorensis* Jepson, Man. Fl. Pl. Calif., 812. 1925.

Stems delicate, angled, 1–3 dm. long, hispid or glabrate; blades of cotyledons orbicular, 7–8 mm. in diameter, on slender petioles nearly twice as long, deciduous; lower leaves opposite, the upper alternate, lower oblong to ovate, 1.5–2.5 cm. long, 0.5–1.8 cm. broad, pinnately divided into 5–7 usually orbicular, petiolulate, usually remote divisions, entire or 1–3-toothed, petioles slender, about equalling blades, uppermost leaves alternate, short-petioled or

sessile, lanceolate to ovate, 3–5-lobed or entire, all more or less hispid with often pustulate hairs or glabrate, stomatiferous below only; flowers solitary in the axils or opposite the alternate leaves on slender pedicels; calyx broadly campanulate, lobes ovate-lanceolate, 2–3.5 mm. long, 0.5–1.5 mm. broad, acute or obtuse, auricles about 0.5 mm. long, ovate, spreading or reflexed; corolla pelviform, white or bluish, 5–10 mm. broad, lobes obovate-obtuse or emarginate, often pilose at apex; corolla scales triangular, free edge glabrous or ciliate, or reduced to hairy lines; filaments about equalling tube, anthers oblong, 0.8–1 mm. long; style 2.5–3.5 mm. long, cleft about one-half, conspicuously exserted from calyx; mature capsule 2–5 mm. in diameter, exceeding calyx; seeds 2–4, yellowish brown, ovoid, 1–2 mm. in diameter, smooth or minutely roughened; cucullus often papillaeform, deciduous.

Type locality.—"In Nova-California ad sinum Bodega" (Sonoma County, California), no collector noted.

Range.—Sierra Nevada foothills and Coast Ranges from Madera and San Benito counties, California, north to the Rogue River valley, Oregon; Upper Sonoran and Transition zones, chiefly in light shade.

Specimens examined.—OREGON. Josephine Co.: Galice, *Henderson* 5966 (CA, M, RM, S, UO); Grants Pass (1912), *H. S. Prescott* (G, Wil); Rogue River Valley (1884–87), *T. Howell* (G, M, NY, OS, PA, Thompson, UC, UO, US, WS). Jackson Co.: Woodville (Rogue River), *E. W. Hammond* 288 (M).

CALIFORNIA. Locality uncertain: "In valle Sacramento," *Hartweg* 222 (K); "Sacramento Valley," *Fremont* 250 (G, K, NY). Siskiyou Co.: Forks of Salmon, *Eastwood & Howell* 5063 (CA); Yreka Creek, *L. C. Wheeler* 3538 (P). Shasta Co.: Goose Valley, *Eastwood* 776 (CA, Clokey, G, M, NY, US); McCloud River, *Heller* 13,023 (CA, CU, F, G, M, NY, PA, S, US); Pit River Ferry, *H. E. Brown* 261 (CA: type of *N. flaccida,* UC, US). Trinity Co.: Weaverville, *D. K. Kildale* 10,747 (S). Humboldt Co.: Hupa (1902), *Manning* (S, UC); Trinity River Valley, *Tracy* 15,292 (S, UC). Mendocino Co.: Lyons Valley (1901), *Eastwood* (M, NY, RM, UC, US); Mill Creek (1901), *Eastwood* (S, UC, US), 3344 (CA, G, NY); South Mill Creek Cañon, *Abrams* 6935 (NY, S, US); Strong Mountain (1902), *Eastwood* (NY, UC, US); Ukiah, *Bolander* 4647 (CU, F, M, UC, US). Tehama Co.: Paskenta, *Constance & Morrison* 2185; Payne Creek, *Eastwood & Howell* 1859 (CA). Butte Co.: Berry Canyon, *Heller & Brown* 5507 (CU, F, G, M, NY, P, PA, RM, S, US); Big Chico Creek, *Bruce* 2037 (CA: type of *N. glauca,* NY, P, S), 2037*a* (CA: type of *N. fallax*), *Heller* 10,720 (F, G, NY, PA, S, UC, US), 11,216 (CA, F, G, M, NY, OS, PA, S, UC, US); Big and Little Chico creeks, *Constance & Morrison* 2177; Butte Creek, *Heller* 12,671 (CA, Clokey, F, G, M, NY, OS, PA, S, US); Centerville, *Heller* 11,843 (CA, F, G, M, NY, OS, S); Chico Creek, *Heller* 13,912 (CA, F, G, M, NY, P, RM, S, Thompson, UC, UO, US); Clear Creek–Paradise, *Heller* 11,316 (CA, CU, F, G, M, NY, OS, S, UC, US); Enterprise, *Heller* 11,888 (CA, F, G, M, NY, OS, S, US); Oroville, *H. M. Hall* 8025 (F, G, M, NY, OS, P, PA, RM, S, UC, UO, US, UW); Pine Creek, *Heller* 12,985 (CA, CU, F, G, M, NY, PA, S US). Glenn Co.: Alder Springs, *Heller* 11,436 (CA, CU, F, G, M, NY, OS, PA, S, UC, US); Mud Flat–Bennet Spring, *Heller* 12,345 (CA, F, G, M, NY, OS, PA, S); Newville, *Heller* 11,831 (CA, Clokey, CU, F, G, M, NY, PA, S, UC, US); Stony Creek, *Constance & Morrison* 2187. Colusa Co.: Cache Creek, *Constance* 2146; Lodoga, *A. Carter* 1384 (UC); Sycamore Slough, *Ferris* 606 (M, NY, S). Sutter Co.: Marysville Buttes, *Heller* 7562 (F, G, M, NY, PA, S, UC, US); North Butte, *Wieslander*

390 (VTM); South Butte, *Heller* 11,798 (CA, Clokey, CU, F, G, NY, OS, PA, S, UC, US). Yolo Co.: Putah Creek, *Constance* 2045; Rumsey, *Hoover* 2846 (Hoover, UC). Lake Co.: Bartlett Springs, *Mason* 11,743 (UC); Clear Lake (1900), *Eastwood* (CA: type of *N. hispida*); Clear Lake–Bartlett Mountain, *Abrams* 12,384 (NY, S); Putah Creek, *Constance* 2141. Napa Co.: Calistoga, *Jepson* 4023 (Jepson); Dry Creek, *Constance* 2134; Howell Mountains, *Constance* 2035; Mount Saint Helena (1900), *Eastwood* (CA: type of *N. divaricata*), *C. F. Baker* 2610 (G, M, NY, P, UC, US), *Eastwood* 4689 (CA, G, US), *Abrams* 12,613 (F, NY, P, S); Napa Valley, *Thurber* 493 (F, G, NY). Sonoma Co.: *E. Samuels* 174 (G, US); Cazadero, *Heller* 6619 (CA-part, F, G, M, NY, P, PA, RM, S, UC, UO, US); Cloverdale, *Peirson* 6553 (P, Peirson, UC); Russian River (1886), *K. Brandegee* (CA: type of *N. inaequalis*); Salmon Creek, *Constance* 2151 (topotypes of *N. heterophylla*); Santa Rosa Creek, *Bolander* 3802 (NY, UC, US), 3811 (F, NY, UC, US); Trenton, *Heller & Brown* 5075 (CU, F, G, M, NY, P, PA, RM, S, US); Windsor (1901), *D. Swett* (NY, S, UC, US). Marin Co.: Fairfax (1895–98), *Eastwood* (CA: type of *N. nemorensis*); Kentfield (1912), *Eastwood* (CA, G, US); Mill Valley (1901), *Eastwood* (NY, S, UC, US); Ross Valley, *Brewer* 938 (UC, US), (1915), *Eastwood* (CA, G, NY, US); Sausalito, *Kellogg & Harford* 785 (M, NY, US). Solano Co.: Araquipa Hills, *Jepson* 15,089 (Jepson); Tolenas Spring (1898), *Setchell* (UC). Sacramento Co.: Folsom, *H. F. Copeland* 1416 (P, S). Yuba Co.: Middle Fork of Yuba River, *Constance* 2292; Texas Hill Road, *Eastwood* 17,928 (CA, UC); Timbuctoo, *Constance & Morrison* 2175. Sierra Co.: Downieville (1928), *Vortriede* (CA). Nevada Co.: Grass Valley, *Eastwood & Howell* 4343 (CA, F, NY); Nevada City, *Constance* 2286; Rough & Ready, *Constance & Morrison* 2174. Placer Co.: American Fork, *Fremont* 42 (NY); Applegate (1899), *H. Smith* (CA: type of *N. tenera*), *Constance & Morrison* 2171; Auburn (1891), *Ames* (F, G); Big Cañon, *Jepson* 18,614 (Jepson). Eldorado Co.: New York Ravine (1907), *K. Brandegee* (P, UC); Nashville, *Jepson* 18,660 (Jepson); North Fork of Cosumnes River, *Constance & Morrison* 2166. Amador Co.: Drytown, *Hansen* 2064 (CA, M, UC, US); Mokelumne River, *Constance & Morrison* 2163. Calaveras Co.: Calaveras, *Heermann* (PA); Calaveras River (1850), *C. D. Gibbons* (NY); Green Mine, *Jepson* 1785 (Jepson, UC); San Andreas, *Constance & Morrison* 2162. San Joaquin Co.: Live Oaks (1879), *Rattan* (S); Stockton, *Stanford* (UC). Contra Costa Co.: Deer Flat, *Constance & Morrison* 2190; Donner Canyon, *Bowerman* 1838 (UC); Mitchell Cañon, *C. F. Baker* 2812 (G, M, NY, P, US), *Eastwood* 4466 (CA, G, US); Mount Diablo (1883), *K. Curran* (CA: type of *N. decumbens*), *J. T. Howell* 1659 (CA, F, UC); Nortonville, *Mason* 5052 (UC); St. Mary's College, *J. T. Howell* 11,218 (CA, G, NY, P, UC, US); Wildcat Canyon, *Constance* 2031. Alameda Co.: Alameda, *Kellogg & Harford* 785 (CA, G); Alameda Creek Canyon, *Constance* 2230; Berkeley, *Chandler* 6075 (F, G, M, NY, OS, P, PA, RM, S, UC, UO, US, UW); Berkeley Hills, *Chandler* 1803 (RM, S, UC, US), 1804 (NY, P, RM, S, UC, US); Oakland (1853–54), *Bigelow* (G, K, NY, PA, S, US). San Francisco Co.: San Francisco (1880), *Kellogg* (M). San Mateo Co.: San Bruno Hills (1922), *Eastwood* (CA). Santa Clara Co.: Alum Rock, *Heller* 7275 (F, G, M, NY, OS, PA, RM, S, UC, US); Copernicus Peak, *Sharsmith & Sharsmith* 917 (UC); El Toro, *Constance & Hoover* 2049; Guadalupe Mine, *Constance* 2074; Los Gatos, *Heller* 7292 (CA, F, G, M, NY, OS, PA, RM, S, UC, US); Mount Day, *Heller* 8928 (F, G, M, NY, PA, S, US); Mount Hamilton, *Heller* 8620 (G, M, NY, PA, S, US); Stanford University, *Abrams* 2306 (G, M, NY, P, RM, S), *C. F. Baker* 334 (CA, F, G, M, NY, P,

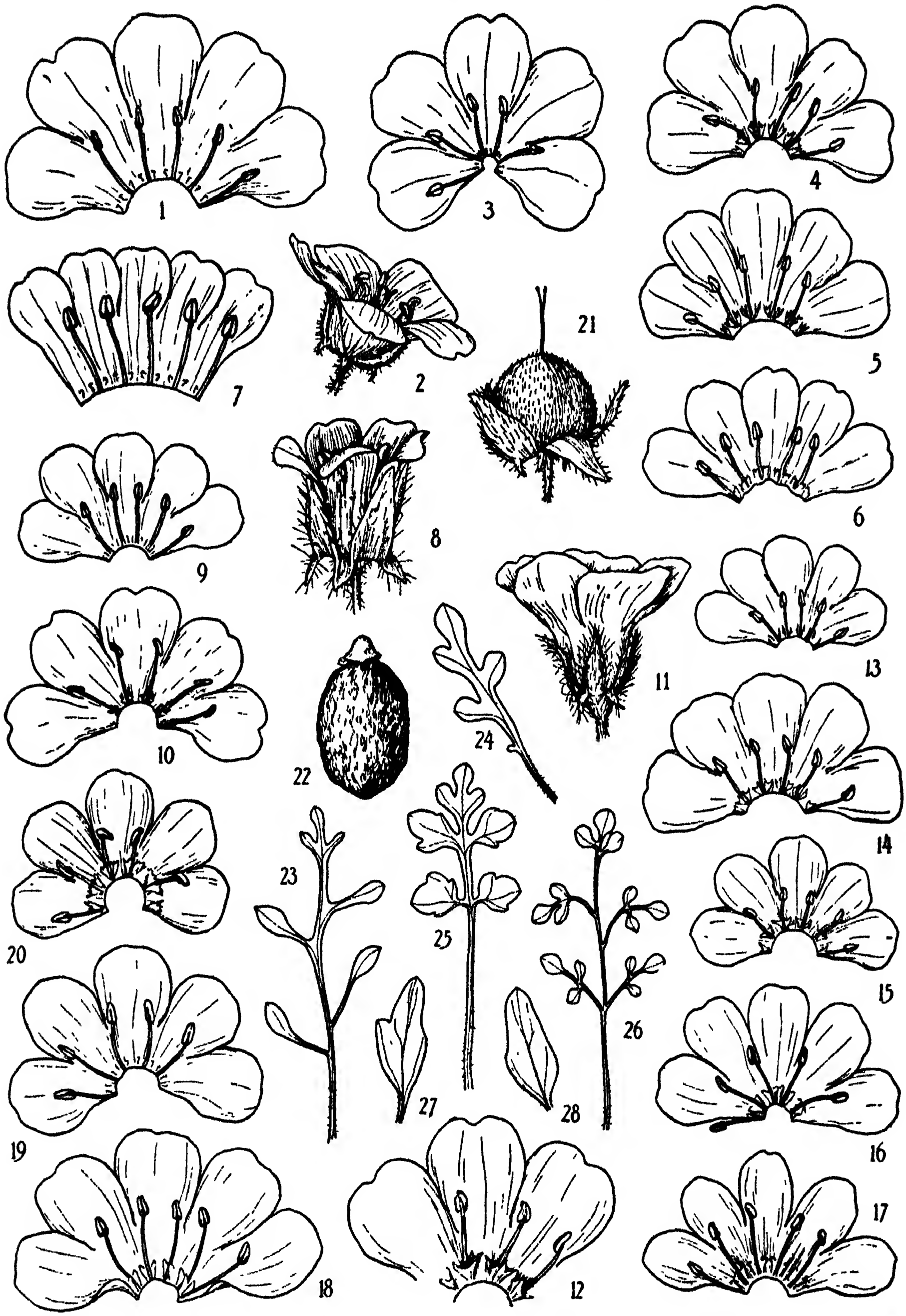


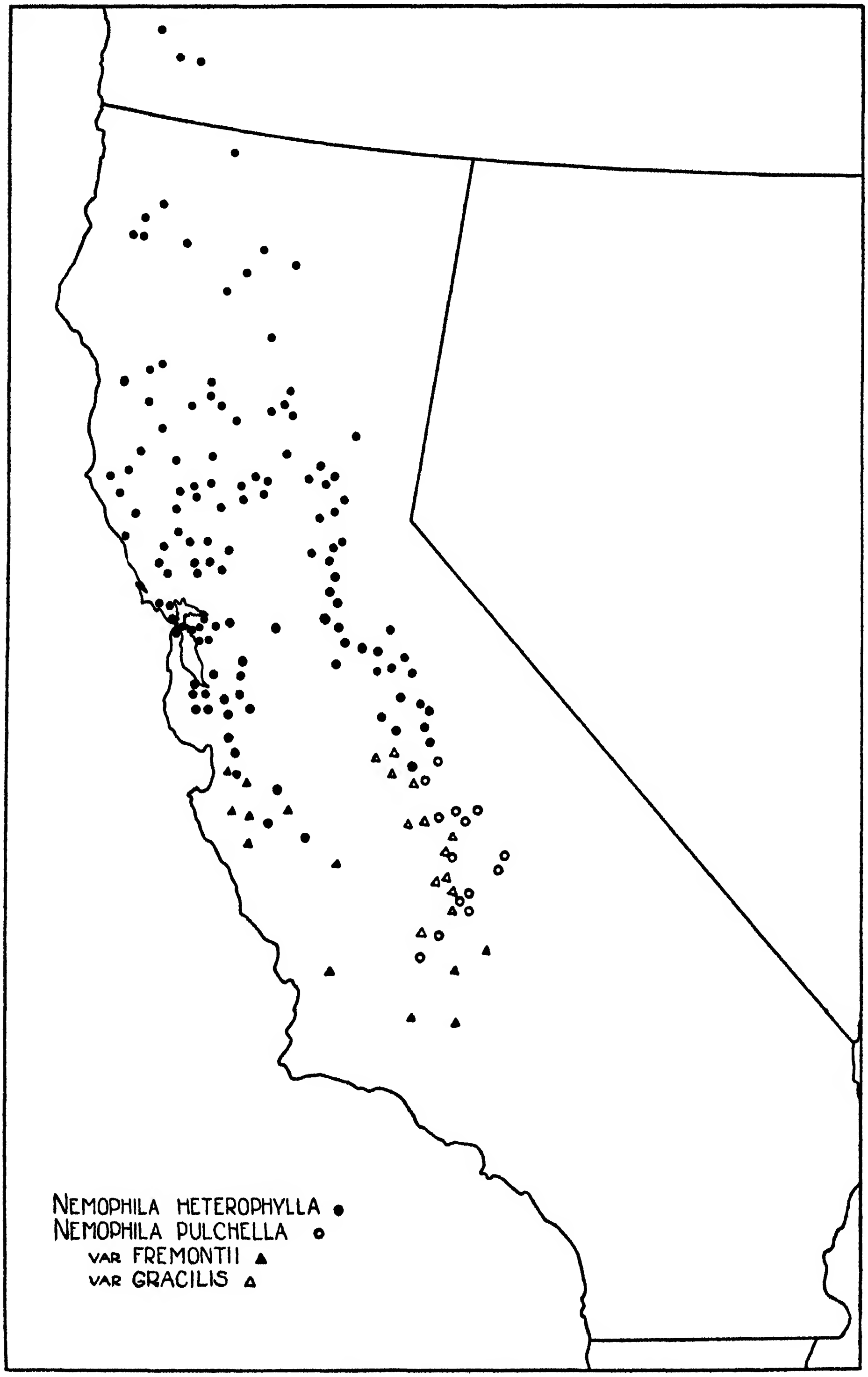
Fig. F. *N. heterophylla.* 1–20, corollas: 1–2, no. 2190, Contra Costa Co., × 3; 3, no. 2185, Tehama Co., × 2½; 4, no. 2171, Placer Co., × 2½; 5, no. 2174, Nevada Co., × 2½; 6, no. 2166, Eldorado Co., × 2½; 7–8, no. 2258, San Benito Co., × 5; 9, no. 2230, Alameda Co., × 2½; 10, no. 2045, Yolo Co., × 2; 11–12, no. 2131, Mariposa Co., × 3; 13, no. 2177, Butte Co., × 2½; 14, no. 2163, Amador Co., × 2½; 15, no. 2162, Calaveras Co., × 2½; 16, no. 2151, Sonoma Co., × 3; 17, no. 2049, Santa Clara Co., × 4; 18, no. 2134, Napa Co., × 4; 19, no. 2187, Glenn Co., × 2½; 20, no. 2196, Tuolumne Co., × 3. 21, fruit × 4; 22, seed × 7; 23–28, leaves × 1.

RM, S, UC, US, WS), *Elmer* 4835 (CA, M, NY, OS, P, S, UC, UO, US). San Benito Co.: San Benito Cañon, *Jepson* 2721 (Jepson); San Carlos Peak, *Constance & Morrison* 2258; Tres Piños Creek, *Constance* 2229. Stanislaus Co.: Knights Ferry, *Hoover* 783 (Hoover, UC), *Constance* 2194. Tuolumne Co.: Chinese Camp, *Constance* 2196; French Flat, *Ferris* 1561 (CA, Clokey, P, S, US); Hog Ranch Road (1897), *Congdon* (CA: type of *N. exilis*); Mather, *Keck* 496 (G, S, UC). Mariposa Co.: Cathay Valley, *Eastwood* 4356 (CA, Clokey, G, NY, US); Chowchilla School, *Jepson* 12,795 (Jepson); Clark's (1883), *Meehan* (PA); Merced Grove, *Hall & Babcock* 3417 (NY, S, UC, US); Mormon Bar (1901), *Congdon* (CA: type of *N. diversifolia*), *Constance & Mason* 2131; Yosemite Valley, *Bolander* 4920 (NY, UC), *Abrams* 4442 (G, P, S), *Babcock* 1070 (F, G, M, NY, RM, UC, US). Madera Co.: North Fork of Willow Creek, *Constance* 2369.

Chandler (1902) has thoroughly demonstrated that the numerous segregates, based chiefly upon differences in the shape of the corolla, the size and shape of the corolla scales, and the degree of division of the exceedingly variable leaves, are not natural units. He accordingly reduced eleven of Eastwood's "species" to synonymy with "N. exilis." Much nomenclatorial confusion has been caused by this substitution of the name *N. exilis* for *N. heterophylla.* Chandler had obtained from St. Petersburg a supposed type fragment of *N. heterophylla.* This proved to be, however, a fragment of *N. Menziesii,* and Chandler was thus led to reduce *N. heterophylla* to synonymy under the very different *N. Menziesii* and to substitute *N. exilis* for the plants which had been first named *N. heterophylla.* Brand pointed out this error and reëstablished the true identity of *N. heterophylla,* but continued to maintain *N. exilis* as distinct from it. Together with most of the other small-flowered species, *N. heterophylla* was long submerged in *N. parviflora* and was so treated by most American botanists prior to the appearance of Miss Eastwood's paper.

Brand attempted to maintain *N. nemorensis* as a species distinct from *N. heterophylla* because of its narrower or obsolete corolla scales. The untrustworthiness of such characters has been shown previously. The two occupy an ecologically and geographically similar area, and there seems to be no reason for retaining them as separate entities, as has been indicated by Nelson and Macbride (1918). However, these authors' suggestion that the inland plants, because of their more divided leaves and more abundant pubescence, be separated varietally from the coastal, does not receive acceptance in this paper. These characters seem to be correlated more closely with local environment, particularly with exposure, than with geographical distribution. Plants of the Sierran Transition zone are much more like those of the coastal forests than either are like the intervening Upper Sonoran populations. Frequent exceptions both to conditions of foliage and to pubescence occur to nullify the usefulness of the proposed distinction.

Extensive field study has not only failed to reveal the validity of any of the previously described segregates from this species, but has shown the species to be a single natural unit, without significant varietal populations. Consid-



Map 6. Distribution of *N. heterophylla*, *N. pulchella* and vars. *fremontii* and *gracilis*.

ered as a single species, in spite of variations in habit, pubescence, leaf division, size of corolla, and form and degree of development of corolla scales, *N. heterophylla* presents a continuous and logical distribution. It is commonly associated with the Upper Sonoran foothill belt, which is dominated by *Pinus Sabiniana, Quercus Douglasii,* and *Q. Wislizenii.* It thus encircles the northern and central portions of the Great Valley. In a number of places it strays out of these confines and enters the transition zone of both the Sierra Nevada and the coastal humid strip. *N. heterophylla* was originaly described from Bodega Bay, where it occupies the Redwood border forest, nearly at sea level, and *N. exilis* was published upon plants collected in Yosemite Valley, in the Sierran Transition zone.

The most distinctive characters of this species are, perhaps, the pelviform corolla, which is usually at least twice as long as the calyx, the slender style, prominently exserted from the calyx when the corolla has fallen, and the leaves with their five or seven remote, orbicular, petiolulate divisions. If the most stable characters for delimiting species are those which remain relatively constant when others vary confusingly, then leaf form affords the most reliable criterion for distinguishing *N. heterophylla* from *N. parviflora.* In the Coast Ranges of Santa Clara and San Benito counties, *N. heterophylla* occurs with smaller, shorter, and narrower corollas and shorter styles, features which closely simulate those of *N. parviflora,* but leaf form permits at least practical separation. Because the two species are essentially different throughout the remainder of their very distinct ranges and do not appear to be even closely related, I believe that they should be maintained as separate species. *N. pulchella* and its varieties manifest leaf variations almost identical with those of *N. heterophylla.* The relationship between these species is exceedingly close, but the reduced or obsolete auricles, the proportionately longer filaments, and the rotate corolla of *N. pulchella,* together with its different range, render the two sufficiently distinct.

11. **Nemophila pulchella** Eastwood

N. pulchella Eastwood, Bull. Torrey Club, 28:157. 1901.
N. exilis var. *pulchella* Chandler, Bot. Gaz., 34: 214. 1902.
Viticella pulchella Macbride, Contr. Gray Herb., 59:31. 1919.

Stems angled, 1–4 dm. long, loosely hispid, pilose or glabrate; blades of cotyledons orbicular, 3–4 mm. in diameter, on petioles of about equal length, withered at anthesis; leaves all opposite or the uppermost occasionally alternate, lower oblong to ovate, 2.5–4.5 mm. long, 1–2.5 mm. broad, pinnately divided into 5 usually remote, petiolulate, orbicular divisions, these usually deeply 1–5-toothed, sinuses broad, petioles about equalling blades, uppermost leaves smaller, short petioled or sessile, oblong or lanceolate, shallowly lobed or toothed or entire, all more or less loosely hispid or pilose, stomatiferous below only; flowers solitary in the axils or opposite the alternate leaves, on long slender pedicels; calyx nearly rotate, lobes oblong-lanceolate, 2–4 mm. long, 0.5–1.5 mm. broad, acute, auricles minute or obsolete; corolla rotate, deep or pale blue with a white center, 5–12 mm. broad, lobes oval or orbicular,

exceeding tube, pubescent on back, whole corolla considerably exceeding calyx; corolla scales linear, the free edge hairy, or obsolete; filaments exceeding tube, anthers linear-oblong, 0.6–0.8 mm. long, exserted between corolla lobes; style 2–3 mm. long, divided about one-half, conspicuously exserted from calyx; mature capsule 3–5 mm. in diameter, exceeding calyx; seeds 2–4, brown or greenish, about 1.8 mm. in diameter, smooth or minutely roughened; cucullus usually shallow, deciduous.

Type locality.—"Salt Creek, Kaweah, Tulare County, California, April 28, 1895, *A. Eastwood.*"

Range.—West slope of the southern Sierra Nevada, California; chiefly in light shade in the transition zone, but extending into the Upper Sonoran.

Specimens examined.—CALIFORNIA. Locality uncertain: "Sierra foothills," *Eisen* (G, US). Madera Co.: North Fork, *Belshaw* 2002 (UC). Fresno Co.: Auckland, *Mason* 11,815 (UC); Big Sandy Valley, *Hoover* 3464 (Hoover, UC); Dunlap–Millwood, *Jepson* 2769 (Jepson); Pinehurst, *Constance* 2219; Tollhouse, *Constance* 2210; Tollhouse Creek, *Constance* 2217. Tulare Co.: Alder Creek, *Abrams* 10,833 (Clokey, P, S); Bear Creek, *Purpus* 1720 (UC); Cedar Creek–Colony Mill, *Jepson* 622 (Jepson); Cramer (1891), *T. S. Brandegee* (UC); Kaweah, *Hopping* 295 (UC); North Fork of Tule River, *Constance & Mason* 2123; Salt Creek (1895), *Eastwood* (CA: type of *N. pulchella*); Sequoia Mills (1894), *Eastwood* (CA). Kern Co.: Blue Mountain, *Hall & Babcock* 5004 (S, UC); Greenhorn Range, *Hall & Babcock* 5027 (S, UC), *Peirson* 867 (P).

This is very close to *N. heterophylla* and exhibits a series of habital forms and foliar variations closely parallel with that species. Chandler (1902) even went so far as to consider *N. pulchella* a variety of *N. heterophylla,* but no connecting links have as yet been reported which would serve to join the two entities into a single species. The southern Sierra Nevada possess many endemic species and varieties, such as *N. parviflora* var. *quercifolia,* with a limited distribution essentially similar to that of *N. pulchella.*

The suggestion that *N. pulchella,* through *N. Menziesii* var. *integrifolia,* connects the large- and small-flowered species of *Nemophila* (upon the fallacious assumption that these represent two natural subgeneric groups) is founded solely upon size, shape, and color of the corollas of these supposed intermediates. The relationship of *N. pulchella* is certainly much closer with *N. heterophylla* than with any phase of *N. Menziesii.*

11*a.* **Nemophila pulchella** var. **gracilis** (Eastw.) n. comb.

N. gracilis Eastwood, Bull. Torrey Club, 28:154. 1901.

N. nemorensis var. *gracilis* Brand, Univ. Calif. Publ. Bot., 4:212. 1912.

Like the species, but very diffuse; most of the leaves alternate and shallowly lobed or toothed; corolla white, rotate, smaller, and scarcely exceeding calyx; style 1–1.5 mm. long, scarcely exserted from calyx; seed usually solitary.

Type locality.—"Near Fresno," Fresno County, California, 1888, *Buckminister.*

Range.—Western foothills of the Sierra Nevada, from northernmost Kern

County to southernmost Mariposa County, California; growing in light shade in the Upper Sonoran Zone.

Specimens examined.—CALIFORNIA. Madera Co.: Bates Station–O'Neals, *Mason* 5102 (UC); Chowchilla River, *Hoover* 3448 (Hoover, UC); Kelshaw Corners, *Constance* 2200. Fresno Co.: Auberry, *Constance* 2207; Big Table Mountain, *Quibell* 951 (P); Fresno (1888), *Buckminister* (CA: type of *N. gracilis*); Pollasky, *Heller* 8151 (CA, F, G, M, NY, PA, S, US); Squaw Valley, *Constance* 2225. Tulare Co.: Exeter, *Parks & Parks* 0406 (CA, M, P, UC, US), *Constance & Mason* 2101; Grapevine Spring (1898), *Woolsey* (UC); Kaweah, *Hopping* 8 (S, UC), 257 (UC), 533 (UC); Lindsay, *Munz* 9058 (P); North Fork of Tule River, *Constance & Mason* 2123*a*; Old Colony Mill (1906), *K. Brandegee* (UC); Three Rivers–Lemon Cove, *Abrams* 10,836 (S). Kern Co.: Woody–Glennville, *L. Benson* 3278 (S, UC).

The characters of this variety may be trivial, but it has a nearly independent geographical range and connects so closely the otherwise distinct *N. pulchella* and its var. *fremontii* as to preclude their being kept as separate species. The size of the corollas and the altitudinal range of the variety are approximately those of var. *fremontii,* whereas its habit and geographical distribution relate it to *N. pulchella,* with which it freely intergrades. If there is any overlapping in range between *N. heterophylla* and any phase of *N. pulchella* in the Sierra Nevada, it will probably be this variety which will be involved. However, *N. heterophylla* usually occurs only in the Transition zone at this end of its range, whereas *N. pulchella* var. *gracilis* is for the most part confined to the Upper Sonoran.

11*b*. Nemophila pulchella var. fremontii (Elmer) Constance

N. fremontii Elmer, Bot. Gaz., 41:319. 1906.

Ellisia fremontii Brand, Pflanzenr., IV. 251. 39. 1913.

Nemophila pulchella var. *fremontii* Constance, Rhodora, 42:39. 1940.

Like the preceding variety, but leaves apparently all opposite, the lowest forming a conspicuous rosette; pedicels short; auricles about 0.5 mm. long or represented by a few reflexed bristles or wanting; corolla semirotate, approximately equalling calyx; corolla scales reduced to hairy lines; style 0.5–1 mm. long, not exserted from calyx; seeds mostly 2–4.

Type locality.—"On Fremont's Peak of the Gabilan mountains, San Benito County, California," May, 1903, *A. D. E. Elmer* 4901.

Range.—Tehachapi Mountains and Kern River Canyon around the southeastern end of the San Joaquin Valley and north in the inner Coast Ranges to Stanislaus and eastern Monterey counties; growing in light shade, Upper Sonoran zone.

Specimens examined.—CALIFORNIA. Stanislaus Co.: Las Garzas Creek, *Hoover* 4220 (Hoover, UC). Monterey Co.: Abbotts Ranch, *Ferris* 1914 (S); Big Pinnacles, *Ferris* 4136 (S); Jamesburg, *Constance & Hoover* 2050. San Benito Co.: Emmet–Panoche Pass, *Abrams & Borthwick* 7900 (S); Fremont's Peak, *Elmer* 4901 (M, NY, P, S, UC, US: isotypes of *N. fremontii*); Tres Piños River, *Abrams & Borthwick* 7880 (S); Tres Piños Creek, *Constance & Hoover* 2067. Fresno Co.: Zapato Chino Creek, *Jepson* 15,366*a* (Jepson).

San Luis Obispo Co.: La Panza Range, *Constance & Beetle* 2534. Kern Co.: Clear Creek, *L. Koch* 89 (Baker, UC); Girard Station, *Heller* 7718 (F, G, M, NY, PA, S, UC, US); Hobo Hot Springs, *Hoover* 3159 (Hoover), *Mathias*

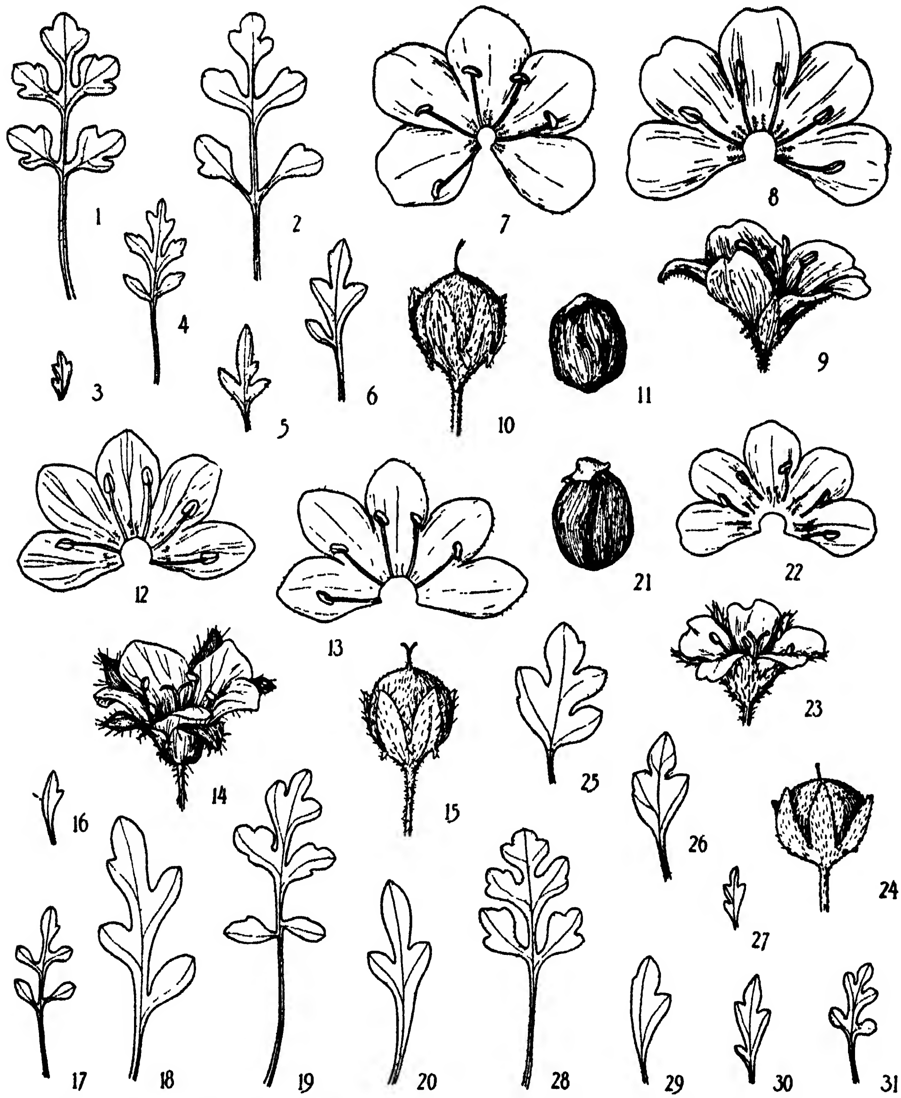


Fig. G. *N. pulchella.* 1–6, leaves × 1; 7, corolla, no. 2210, × 3; 8–9, corolla, no. 2123, × 3; 10, fruit × 4; 11, seed × 7. Var. *gracilis.* 12 and 14, corolla, no. 2101, × 4; 13, corolla, no. 2200, × 5; 15, fruit × 4; 16–20, leaves × 1. Var. *fremontii.* 21, seed × 7; 22–23, corolla, no. 2050, × 6; 24, fruit × 4; 25–31, leaves × 1.

1349 (UC), *Constance & Mason* 2117; San Emidio Cañon, *Davy* 2070 (UC); mouth of Kern River Canyon, *Mathias* 1325 (UC).

Elmer described *N. fremontii* as having auricles on the calyx, but Brand failed to detect these on the type collection and so removed the entity to *Ellisia,* with which it certainly is not closely related. This transfer indicates, perhaps

more clearly than anything else could, how artificial had become the distinction between *Nemophila* and *Ellisia* as constituted by Brand and others. The same colony of var. *fremontii* often has individuals which possess obvious auricles and others which lack them entirely, the plants being quite indistinguishable from each other except for this fact. Brand (1913) cited specimens referable here under *N. nemorensis* var. *gracilis, N. parviflora* var. *quercifolia,* and *E. fremontii.*

Little known and seldom collected, *N. fremontii* was first thought to represent a distinct species. Its very close resemblance to *N. pulchella* var. *gracilis,* however, makes it scarcely distinguishable from that plant, and suggests the advisability of placing these three entities close together in the classification. The distribution of var. *fremontii* is unique, but intensive collecting in the scantily known inner south Coast Ranges should reveal a similar range for many other plants.

SPECIES EXCLUDED

1. *N. appendiculata* Spreng., Syst., 1:569. 1825. = Hydrophyllum appendiculatum Michx.

2. *N. arizonica* M. E. Jones, Contr. West. Bot., 12:50. 1908. = Pholistoma auritum var. arizonicum (M. E. Jones) Constance.

3. *N. aurita* Lindl., Bot. Reg., 19: t. 1601. 1833. = Pholistoma auritum (Lindl.) Lilja.

4. *N. aurita* var. *arizonica* Brand, Pflanzenr., IV. 251. 45. 1913. = Pholistoma auritum var. arizonicum (M. E. Jones) Constance.

5. *N. erodiifolia* Millsp. ex Millsp. & Nutt., Field Mus. Publ., 312, Bot. Ser., 5:205. 1923. = Pholistoma racemosum (Nutt. ex Gray) Constance.

6. *N. membranacea* Greene, Man. San Francisco Bay, 252. 1894. = Pholistoma membranaceum (Benth.) Constance.

7. *N. racemosa* Nutt. ex Gray, Proc. Amer. Acad., 10:315. 1875. = Pholistoma racemosum (Nutt. ex Gray) Constance.

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NEW SPECIES AND CHANGES IN NOMENCLATURE IN CREPIS

BY

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THE NEW species and subspecies described below have been discovered in the course of extensive investigations on systematics and cytogenetics of *Crepis*. They will be illustrated and their taxonomic treatment will be discussed more fully in a monograph on this genus. In an earlier forthcoming paper the chromosome numbers and morphology of these new species and subspecies will be reported, together with those of the species and subspecies which are published here as new combinations. The abbrevations indicating herbaria in which specimens are cited are as follows: UC, Herbarium of the University of California; K, Herbarium of the Royal Botanic Gardens, Kew; Sofia, Herbarium of the University of Sofia; B, Herbarium of the Botanical Museum, University of Berlin.

CREPIS ALBIDA Vill. subsp. ASTURICA (Lacaita et Pau) comb. nov. (*Crepis asturica* Lacaita et Pau, ex Lacaita, Cav. Rer. Bot. Acta, 1:7. 1928.)

CREPIS ALBIDA subsp. MACROCEPHALA (Willk.) comb. nov. (*Crepis macrocephala* Willk., Bot. Zeitung, 5[49]:860. 1847.)

Crepis albiflora sp. nov.—Herba perennis humilis glanduloso-pubescens, pilis brevissimis tenuis pallidis; radix brevis praemorsa; folia omnia caudicalia parva oblanceolata pinnatifida et dentata petiolata; caules scapiformes vel 1-furcati; capitula mediocria multiflora; involucrum campanulatum nigroviride; sqamae exteriores inaequales ovatae vel lanceolatae ciliatae, interiores lanceolatae aucutae intus glabratae in dorso carinatae pubescentia; receptaculum glabratum; corolla 14 mm. longa, ligula 10 mm. longa alba dentibus purpureis, tubo pubescenti; antherae circa 4 mm. longae flavae; rami styli 2.5 mm. longi flavi; achaenia pallida 3.75–4.5 mm. longa 0.75 mm. lata incurvata paululum attenuata circa 20-striata; pappus albus 5 mm. longus 2-seriatus tenuus mollis persistens.

Known only from the type locality.

TURKEY ("western Armenia"): Kop Dagh, Baiburt, 2440 m., open tops of hills, limestone scree, *E. K. Balls 1795* (UC 565326) type.

Crepis albiflora is most nearly related to *C. dioritica* Schott. et Kotschy, which occurs in southern Anatolia, but it differs from that species in the nature of the indumentum of leaves and stems, in the larger florets and anther-tubes, with different anther-appendages, and in the white or nearly white ligules with purple teeth.

CREPIS APULA (Fiori) comb. nov. (*Crepis Suffreniana* (DC.) Lloyd var. *apula* Fiori, ex Fiori, Paol. et Bég., Fl. Anal. Ital. 3:433. 1904.)

CREPIS AUREA (L.) Cass. subsp. TYPICA nom. nov. (*Leontodon aureus* L., Syst. ed. 10, 1193. 1758–59; *Crepis aurea* Cass., Dict. 25:88. 1822.)

CREPIS AUREA subsp. LUCIDA (Ten.) comb. nov. (*Apargia lucida* Ten., Fl. Neap. 2:164. 1820.)

CREPIS CROCEA (Lam.) comb. nov. (*Hieracium croceum* Lam., Encyl. Meth. 2:360. 1786.)

CREPIS DIOSCORIDIS L. subsp. TYPICA nom. nov. (*Crepis Dioscoridis* L., Sp. Pl. ed. 2, 1133. 1763.)

Crepis Dioscoridis subsp. **argolica** subsp. nov.—Herba annua vel biennis 1–1.5 dm. alta; radix robusta lignea; caudex brevus ± inflatus ad summitatem pluricipitus; folia caudicalia evanida interdum 14 cm. longa 2.5 cm. lata oblanceolata runcinato-pinnatifida petiolata glabra; folia caulina similia vel linearia acriter auriculata; caules brevi divaricati ad basim ramosi, ramis divaricatis elongatis 1–3-furcatis semiprocumbentibus glabris; peduncli 4–13 cm. longi vel longiores arcuati ad summatatem inflati fistulosi; capitula erecta multiflora; involucra 9–11 mm. longa 7–10 mm. lata breve glanduloso-pubescentia; squamae exteriores 6–8 purpureae, interiores circa 12; corolla 11 (interdum 18) mm. longa, ligula 6 (13) mm. longa 2 (3) mm. lata flava; antherae 3–4 mm. longae; rami styli 2–2.5 mm. longi flavi; achaenia biformia, exteriora alba 3.5–4.5 mm. longa 2 mm. lata valde incurvata a latere compressa 3-alata, alis ad summitatem spinulosis, interiora flavida 4.5–5 mm. longa leviter incurvata irregulariter fusiformia et costata in rostrum brevissimum attenuata; pappus copiosus albus 3–3.5 mm. longus caducus.

Known only from the type locality.

GREECE: Argolis, Bay of Argos, near Nea-Kios, south of Argos, gravelly strand 10–15 m. above upper limit of high tide, among herbs, *Babcock 322* (UC 429365) type.

Crepis Dioscoridis subsp. **tirynica** subsp. nov.—Herba annua vel biennis circa 3 dm. alta; radix tenua lignea; caudex simplex; folia caudicalia evanida interdum 15 cm. longa 3 cm. lata oblanceolata obtusa lyrato-pinnatifida petiolata parce pubescentia eglandulosa cito arescens; folia caulina similia vel linearia acuminata auriculata; caules numerosi elongati semidecumbentes dichotomo-ramosi, ramis strictis pedunculatis vel 1–5-furcatis; pedunculi 3–18 cm. longi arcuati ad summitatem paululum inflati fistulosi; capitula erecta mediocria multiflora; involucra 9–12 mm. longa 7–9 mm. lata; squamae exteriores 7–8 inaequales linearia, interiores circa 12 eglanduloso-setosae apices pappi excedentes; receptaculum areolatum glabrum; corolla circa 14 mm. longa, ligula 1.5 mm. lata flava concolor, tubo circa 4 mm. longo pubescenti; antherae circa 4 mm. longae flavae; rami styli 2 mm. longi flavi; achaenia subviridi-flavescentia 3.5–4.5 mm. longa biformia, marginalia valde incurvata a latere compressa 4–5-costata 3-alata ad summitatem contracta, interiora leviter incurvata valde 4–5-costata ad apicem abrupte contracta vel breve rostrata ad basim praesertim callosa; pappus albus quam involucrum brevior deciduus.

Known only from the type locality.

GREECE: Argolis, Tiryns, St. Elias monastery, *Costopoulos* in 1931 (UC 446468) type.

CREPIS DIOSCORIDIS subsp. TUBAEFORMIS (Hal.) comb. nov. (*Crepis tubaeformis* Hal., Consp. Fl. Graec. 2:230. 1902.)

CREPIS HOKKAIDOENSIS nom. nov. (*Crepis burejensis* in Miyabe et Miyake, Fl. Saghalin 284. 1915, non Fr. Schmidt.)

Crepis hypochaeridea (DC.) Thell. subsp. **rhodesica** subsp. nov.—Planta 1.2–2, 3 dm. alta; folia 3–7 cm. longa interdum 2 cm. lata oblanceolata dentata pubescentia, pilis tenuibus albis glandulosis; caules 2–3-furcati, ramis strictis pedunculatis vel bicephalicis; involucrum circa 12 mm. longum glandulosum; corolla circa 13 mm. longa; antherae 3.7 mm. longae; rami styli 1.5 mm. longi flavi; achaenia 7–10 mm. longa rostrata; pappus 5–6 mm. longus.

Southeastern Southern Rhodesia and northwestern Northern Rhodesia; probably in the intermediate region.

SOUTHERN RHODESIA: high veldt, 1300–1600 m., *Walters 2322* (K) type.

Crepis hypochaeridea subsp. **brevicaulis** subsp. nov.—Planta 1–1.2 dm. alta; folia 3–7 cm. longa interdum 1.5 cm. lata oblanceolata denticulata puberula vel glabrata; caules remote 2–3-ramosi, ramis divaricatis pedunculatis vel bicephalicis; involucrum 9–12 mm. longum glandulosum et setulosum; corolla 12–13 mm. longa; antherae 4 mm. longae; rami styli 1.2–1.5 mm. longi flavi; achaenia 6.5–8.5 mm. longa, rostro 2–3 mm. longo; pappus 5.5–6 mm. longus.

Distinct from subsp. *rhodesica* in the dwarf, spreading habit, longer outer involucral bracts, black setules on inner bracts, pubescence of corolla-tube, narrower and longer beaked achenes.

Known only from the type locality where it was observed to be very local.

TRANSVAAL: Zoutpansberg Mts., Pisang Hoek, upper hill slopes, *Galpin* in 1935 (UC 540739) type.

Crepis ircutensis sp. nov.—Caulis supra 4.5 dm. altus teretus striatus vel sulcatus glabrescens purpurellus remote ramosus paniculatus, ramis inferiores elongatis strictis ad summitatem cymose 4-ramosis, ramulis pedunculatis, inflorescentia aggregata cymoso-corymbiformia; folia caulina inferiores 7 cm. longa 0.7 cm. lata oblanceolata acuta repando-denticulata breve petiolata glabrata, nervo albo prominente; folia altera gradatim reducta linearia sessilia superiora bracteaformia; pedunculi 4–8 cm. longi stricti vel arcuati infra glabrati supra puberuli vel glanduloso-pubescentes, apud capitulum bracteis paucis parvis; capitula erecta mediocria circa 30-flora; involucrum cylindrico-campanulatum 10–12 mm. altum ad medium 5–6 mm. latum nigroviride tomentulosum glanduloso-pubescens; squamae exteriores 5–6 lineares acutae quam interiores triplo breviores; squamae interiores 10–14 lanceolatae acutae ad apicem ciliatae ventrale glabrae et albo-nervulosae ultimo in dorso tenuiter carinatae et ad basim induratae; receptaculum glabrum; corolla 13–14 mm. longa, ligula 2.25 mm. lata, tubo 4 mm. longo glabro; antherae 3.75 mm. longae, appendicibus 0.8 mm. longis sagittatis, filamentis 1 mm. longioribus; rami styli circa 2 mm. longi 0.15 mm. lati flavi; achaenia fusco-purpurea ad apicem flavidula 4.5–5 mm. longa 0.8 mm. lata subtereta fusiformia circa 13-costata, costis tenuis glabris vel muriculatis; pappus albus circa 7 mm. longus 2-seriatus, setis inaequalibus persistentibus.

Known only from the type locality.

SIBERIA: Irkutsk Prov., Sajan Mts., along the upper course of the Ircut and Oka rivers, *Komarov*, Aug. 31, 1902, flowers and fruits (B) type.

Crepis ircutensis is intermediate between *C. Bungei* Ledeb. and *C. tectorum* L., but it can not be considered to be a hybrid between them for many reasons.

CREPIS LYBICA (Pamp.) comb. nov. (*Crepis taraxacifolia* Thuill. var. *lybica* Pamp., Nuovo Gior. Bot. Ital. n.s. 24:158. 1917.)

CREPIS MULTICAULIS Ledeb. subsp. GENUINA (Rgl.) comb. nov. (*Crepis multicaulis* var. *genuina* Rgl., ex Regel, Rach et Herder, Bull. Soc. Nat. Moscou 32:216. 1859; *Crepis multicaulis* Ledeb., Fl. Altaica 4:125. 1833.)

CREPIS MULTICAULIS subsp. CONGESTA (Rgl.) comb. nov. (*Crepis multicaulis* var. *congesta* Rgl., Bull. Soc. Nat. Moscou 40:178. 1867; *C. Stoliczkae* C. B. Clarke, Comp. Ind. 255. 1876.)

Crepis Newii Oliver et Hiern subsp. **Greenwayi** subsp. nov.—Herba perennis 1–2 dm. alta; caudex rectus ligneus circa 1 cm. latus; folia caudicalia numerosa rosulata oblanceolata vel elliptica obtusissima sinuato-denticulata breve petiolata eglanduloso-setulosa; folia caulina parva linearia; caulis erectus non fistulosus 4-ramosus, ramis infernis elongatis 2–4-cephalicis, inflorescentia aggregata cymoso-corymbiformia; capitula mediocria circa 50-flora; involucra campanulata 10 mm. longa tomentulosa; squamae exteriores 10–15

inaequales tenuissimae, interiores circa 15 lanceolatae in maturitate valde carinatae et spongioso-incrassatae; receptaculum areolatum; corolla 10 mm. longa, ligula 7 mm. longa 1.75 mm. lata flava; antherae 3.5 mm. longae; rami styli 1.4 mm. longi flavi; achaenia atropurpureo-fusca fusiformia valde attenuata 10–12-costata; pappus pallido-flavidus 5 mm. longus 1-seriatus persistens.

TANGANYIKA TERRITORY: Iringa Prov., Msima Stock Farm, grassland, 1636 m., *P. J. Greenway 3529 B* (UC 513276) type; Iringa Prov., Njombe, west of Msima Stock Farm, *Lynes D49* (K).

Cultivated specimens, grown in a greenhouse at Berkeley, from seed taken from the type collection, have faithfully reproduced the distinguishing features of this subspecies.

CREPIS PULCHRA L. subsp. TYPICA nom. nov. (*Crepis pulchra* L., Sp. Pl. 2:806. 1753.)

Crepis pulchra subsp. **africana** subsp. nov.—Capitula conspicuiora patentia diuturne; corolla 10–12 mm. longa, ligula 2 mm. lata in dorso purpurea, tubo 3.5 mm. longo; antherae 3–3.5 mm. longae nigro-virides ad basim flavides; rami styli 1.25 mm. longi nigro-virides; achaenia biformia, exterioribus obcompressis 5.5 mm. longis 0.5 mm. latis sine pappo, interioribus teretibus 4.5 mm. longis 0.7 mm. latis spiculatis vel glabris et striatis; pappus albus circa 5 mm. longus.

Known with certainty only from the vicinity of Algiers; but one specimen (in Herb. Missouri Bot. Gard.) collected by Muschler in Upper Egypt, may be this. It may also occur in Morocco.

ALGERIA: Alger, rocks of Telemly, *Maire* in 1930 (UC 544662) type.

Crepis pulchra subsp. **turkestanica** subsp. nov.—Capitula conspicuiora quam in typica patentia diuturne; corolla 10–12 mm. longa, 2.5 mm. lata concolore, tubo 2.5 mm. longo; antherae 3.75 mm. longae vigro-virides; rami styli 1–1.5 mm. longi nigro-virides; achenia biformia, exterioribus obcompressis 5–6 mm. longis 0.3–0.5 mm. latis sine pappo, interioribus teretibus 4–5 mm. longis 0.3–0.5 mm. latis spiculatis vel glabris et striatis; pappus albus 3–5 mm. longus.

Central and southern Turkestan, Afghanistan and westward through Persia and Turkey.

TURKESTAN: ex hort. genet. Calif. 29.2566-4, cult. from seed coll. by Dr. Zaetsev, Tashkent Plant Breeding Station (UC 531830) type; Samarkand dist., Pistaly-tan Mts., *Spiridonow* in 1915 (UC).

CREPIS REUTERIANA Boiss. subsp. TYPICA nom. nov. (*Crepis Reuteriana* Boiss., Diagn. Pl. Orient. Nov. ser. 1, 11:55. 1849.)

Crepis Reuteriana subsp. **Eigiana** subsp. nov.—Caules 0.8–5.5 dm. alti; radix valde lignea elongata; caudex 0.5–2 cm. latus; folia caudicalia oblanceolata acuta repando-dentata vel pinnatifida petiolata dense glanduloso- et eglanduloso-pubescentia; folia caulina similia vel reducta bracteaformia; caules erecti ramosi, ramis strictis vel divaricatis oligocephalis; capitula mediocria 20-flora; involucrum cylindricum 8–13 mm. longum dense glandulosum; squamae exteriores 8–10 parvae, interiores 10–13 valde carinatae et spongioso-incrassatae; corolla 10–15 mm. longa; antherae 3–4.5 mm. longae; rami styli flavi; achaenia flavidula 5–7 mm. longa 1–1.25 mm. lata fusiformia; pappus albus 5–6 mm. longus 2–3-seriatus tenuissimus.

Mountains of northern Liban, northwestern Syria and Cilicia.

SYRIA: northern Liban, *Cedrus* forest above Bscherre, 1880 m., *Eig and Zohary* in 1931 (UC 466625) type. TURKEY: Cilicia, Taurus Range, Bozante hills, 800 m., *Eig and Zohary* in 1931 (UC).

CREPIS SANCTA (L.) comb. nov. (*Hieracium sanctum* L., Cent. Pl. 2:30. 1756; Amoen. Acad. 4:328. 1759; Sp. Pl. ed. 2, 2:1127. 1763 non Georgi; *Lagoseris sancta* (L.) K. Maly, Glasnik zem. muzega u Bosni i Hercegovina 20:556, 562. 1908.)

CREPIS SCAPOSA R. E. Fr. subsp. TARAXACIFORMIS (R. E. Fr.) comb. nov. (*Crepis scaposa* var. *taraxaciformis* R. E. Fr., Svensk. Bot. Tidskr. 22:362, pl. VII, f. 2. 1928.)

Crepis Schachtii Babcock, Magyar Bot. Lap. 33:3, 5, in adnot., 1934. [Although first published before Jan. 1, 1935, since a Latin description was not included with the original description it is given here.]—Herba perennis circa 0.9 dm. alta; caudex ligneus tennus attenuatus in radicem rectam fibrosam; folia omnia caudicalia interdum 9 cm. longa 2 cm. lata oblanceolata subpinnatifida petiolata glanduloso-puberula; caules scapiformes bracteati tenues glanduloso-puberuli; capitula erecta mediocria circa 30-flora; involucrum campanulatum 12–14 mm. longum 6 mm. latum ad basim dense pubescens, pilis setiformis glandulosis pallidis; squamae exteriores circa 10 inaequales interdum 3-plo breviores, interiores circa 15 fere aequales lanceolatae ventraliter glabrae ad basim paululum incrassatae; corolla circa 14 mm. longa, ligula 2.5 mm. lata flava, tubo 4 mm. longo parce et minute pubescenti; antherae 3.75 mm. longae flavae; stylus flavus, ramis 1.25–1.75 mm. longis; achaenia fuscidula 7.5 mm. longa 0.75 mm. lata ad apicem gradatim attenuata 18–20-costata, costis tenuis spiculatis; pappus albus 6–7 mm. longus valde exsertus 1-seriatus persistens.

Known only from the type locality.

BULGARIA (eastern Macedonia): Mt. Ali-Botusch, dry places on calcareous rocks, 1300 m., *Schacht* in 1932 (Sofia).

Crepis Schachtii shows considerable resemblance to *C. bithynica* Boiss., but it is actually closer to *C. pinnatifida* (Willd.) Froel. in respect to its habit, florets and achenes.

CREPIS SETOSA Hall.f. subsp. TYPICA nom. nov. (*Crepis setosa* Hall.f., Roem. Arch. Bot. 1(2):1. 1797.)

Crepis setosa subsp. **Topaliana** subsp. nov.—Herba annua, 0.8–3.5 dm. alta; capitula parviores; involucrum circa 7 mm. longum, ad basim 4–5 mm. latum; corolla 8 mm. longa flava, tubo circa 3 mm. longo pubescenti; antherae 2.5 mm. longi flavae; rami styli 1.5 mm. longi flavidi; achaenia flavo-fusca dimorpha, exteriora 3 mm. longa 0.5 mm. lata a latere compressa gradatim attenuata erostrata vel suberostrata interdum absentia, interiora 3–3.75 mm. longa 0.3–0.4 mm. lata fusiformia subtereta tenuissime et breve rostrata 10-striata valde spiculata; pappus albus 3–3.5 mm. longus.

GREECE: Thessaly, Kato Lehonia near Volo, *Miss Topali* in 1933 (UC 506855) type; Kato Lehonia, grounds of Mr. P. S. Topali, *Babcock 338* (UC); between Kato Lehonia and Drakia, *Babcock 360* (UC); Mt. Pelion, Portaria, *Miss Topali* in 1932 (UC).

CREPIS SUBEROSTRIS Coss. et Durieu subsp. TYPICA nom. nov. (*Crepis suberostris* Coss. et Durieu, ex Batt. et Trab., Fl. de l'Alger 561. 1888–89.)

Crepis suffruticosa sp. nov.—Herba perennis circa 2 dm. alta; caudex robustus ligneus ramosus, ramis brevis crassis ad summitatem foliatis; folia caudicalia numerosa ad 11 cm. longa 1.5 cm. lata oblanceolata obtusa vel acuta dentata in petiolum alatum gradatim attenuata glanduloso-pubescentia; folia caulina similia vel sessilia acuminata valde dentata; caulis erectus fistulosus tomentulosus glanduloso-pubescens vel -setulosus remote ramosus; inflorescentia aggregata cymosa 3–4-cephalica; capitula magniuscula multiflora; involucra campanulata circa 15 mm. longa ad basim in fructu 7 mm. lata tomentosa et dense glanduloso-pubescentia; squamae exteriores 8 inaequales lanceolatae obtusae ventrale pubescentes, interiores 12–16 lanceolatae in maturitate non incrassatae sed reflexae et ventrale valde pubescentes; receptaculum areolatum glabrum; corolla 13 mm. longa, ligula 9.5 mm. longa

1.75 mm. lata flava satura; antherae 3.5 mm. longae; rami styli 1.1 mm. longi flavi; achaenia fusca circa 10 mm. longa 0.75 mm. lata gradatim attenuata 10-costata; pappus pallido-flavidus 6 mm. longus 2-seriatus persistens.

Known only from the type locality, where it was reported by the collector as not common; hence apparently it is a local endemic.

TANGANYIKA TERRITORY: Arusha Prov., Mt. Meru, sandy lava scree, 3787 m., *B. D. Burtt 4060* (K) type; plant grown from seed taken from the type, hort. gen. Calif. 34.3281 (UC).

Crepis suffruticosa is most closely related to *C. kilimandscharica* O. Hoffm. and its allies. At the same time, the habit, stature and scapelike stems with few, large heads in this relic species are reminiscent of *C. alpestris* (Jacq.) Tausch of southern Europe and Asia Minor, which suggests a common origin for the more primitive African and Eurasian species of *Crepis*.

CREPIS SYRIACA (Bornm.) comb. nov. (*Crepis alpina* L. var. *syriaca* Bornm., Beih. Bot. Centralbl. 31(2):237. 1914.)

CREPIS TAYGETICA nom. nov. (*Crepis divaricata* Boiss. et Heldr., Diag. Pl. Or. Nov. ser. 1, 7:13. 1846; Boiss., Fl. Or. 3:836. 1875 non *C. divaricata* [Lowe] F. Schultz.)

CREPIS VESICARIA subsp. HYEMALIS (Biv.) comb. nov. (*Barkhausia hyemalis* Biv., Stirp. Rar. Sic. Man. 1:6, t. 2. 1813.)

CREPIS VESICARIA subsp. MYRIOCEPHALA (Coss. et Durieu) comb. nov. (*Crepis myriocephala* Coss. et Durieu, ex Batt. et Trab., Fl. Alg. 563. 1888–90.)

CREPIS VESICARIA subsp. STELLATA (Ball) comb. nov. (*Crepis taraxacifolia* subsp. *stellata* Ball, Jour. Bot. n.s. 2:371. 1873.)

CREPIS ZACINTHA (L.) comb. nov. (*Lapsana Zacintha* L., Sp. Pl. 2:811. 1753; *Rhagadiolus Zacintha* Desf., Fl. Pedem. 1:227. 1785; *Zacintha verrucosa* Gaertn., Fruct. 2:358. 1791.)

A STUDY OF THE PERISPORIACEAE, CAPNODIACEAE, AND SOME OTHER SOOTY MOLDS FROM CALIFORNIA

BY

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AND

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THE TERM "sooty molds" is applied to those fungi which form a dark superficial film or felt of mycelium over the outer surfaces of plants. They occur rather abundantly in parts of California, usually in correlation with milder temperature and higher humidity. Such physical conditions favor the growth not only of the fungus but of the "honey dew" insects which may contribute to its nutrition (Fraser, 1933, 1934, 1937; Fischer, 1933). Fischer believes that there is probably higher correlation between the species of fungus and associated insects than between the species of fungus and the host plant.

A study of the available California material added new hosts, extended known ranges for already described sooty molds, and revealed one new genus and several new species. The Capnodiaceae and Perisporiaceae which occur in California will be listed, followed by a few records concerning the Sphaeriales, Microthyriales, and Fungi Imperfecti.

PERISPORIACEAE

Dimeriella Pseudotsugae sp. nov. (pl. 67, fig. 1)

Mycelium superficiale, hypophyllum, non subiculoideum, inconspicuum, arachnoideum, non torulosum; perithecia aggregata, soluta, globosa, membranacea, fusco-brunnea, 50–84 μ diam., appendiculis radiantibus, septatis, irregularibus, obtusatis, ad basim non tumidis, 27–57×2.5–5 μ, ostiolum poroideum, inconspicuum; asci ventricosi, breviter pedicellati, octospori, 32–40×9–15 μ; paraphyses nullae; sporidia biseriata, hyalina, fusiformia-elliptica, bicellularia, levia, 10–15×2.5–3.6 μ.

Mycelium superficial, hypophyllous, not subiculoid, obscure, forming a very thin network, hyphae not constricted; perithecia gregarious, free, globose, membranaceous, dark brown, 50–84 μ in diameter, covered with spreading, septate, irregular, obtuse appendages, bases not enlarged, 27–57×2.5–5 μ, ostiole poroid, obscure; asci ventricose, short-pedicellate, 8-spored, 32–40×9–15 μ; no paraphyses; spores biseriate, hyaline, fusiform-elliptical, 2-celled, smooth, 10–15×2.5–3.6 μ.

On lower side of leaves of young *Pseudotsuga taxifolia* (Lamb.) Britt., Mill Creek, Trinidad, Humboldt Co., Calif., May, 1931, J. P. Tracy & H. E. Parks 3680, type, University of California Herbarium 498795.

This material has been compared with descriptions of *Dimerosporium balsamicolum* (Pk.) E. & E., which has been recorded on *Pseudotsuga Douglasii* Carr., but the latter has glabrous perithecia which grow out through the stomata of the host (Wilson, 1928). *Phaeocryptopus nudus* (Pk.) Pet. (=*Asterina nuda* Pk. [1885]) has shorter and wider spores. *Dimerosporium Tsugae* Dearness (1924) differs from *Dimeriella Pseudotsugae* in having smooth perithecia, larger spores, and an evident subiculum.

Dimerium Juniperi Dearness (Dearness, 1926)

On green branches of *Juniperus occidentalis* Hook., Big Bear Lake, San Bernardino Co., Calif., E. Bethel. Material not examined.

Dimerosporium Abietis Dearness (Dearness, 1926)

Hypophyllous on living leaves of *Abies grandis* Lindl., near Trinidad, Humboldt Co., Calif., May, 1931, H. E. Parks. This has not been reported previously from California.

Lasiobotrys affinis Harkness (Harkness, 1884; Bonar, 1928)

On living leaves of *Lonicera hispidula* Dougl. var. *californica* Jeps., Mt. Tamalpais, Marin Co., Calif., June, 1881, H. W. Harkness 2539, type in California Academy of Sciences; Butter Valley, Humboldt Co., Calif., Sept., 1924, Joseph P. Tracy 6874; Mt. Tamalpais, Marin Co., Calif., Dec., 1923, H. E. Parks; Los Gatos Canyon, Santa Clara Co., Calif., Dec., 1923, H. E. Parks 2994.

Lasiobotrys Lonicerae Kze. & Schm.
(Kunze & Schmidt, 1823; Theissen, 1918)

On leaves of *Lonicera ciliosa* Poir., Trinity Summit, Humboldt Co., Calif., Aug., 1936, Joseph P. Tracy 15115, immature. This species is found throughout Europe, but seems to be very rare in North America.

Material of what has been called *Lasiobotrys Lonicerae* var. *Symphoricarpi* Ell. & Ev. or *Lasiobotrys Symphoricarpi* Syd. has been examined, and, although it is immature, sections of it confirm Sydow's report (1920; Bonar, 1928) that it belongs to the Dothidiales and should be called *Rhizogene Symphoricarpi* Syd. Our collection is on *Symphoricarpos mollis* Nutt., Trinity Summit, Humboldt Co., Calif., Aug., 1936, Joseph P. Tracy 15109.

Meliola nidulans (Schw.) Cke. (Cooke, 1882)

On leaves of *Gaultheria Shallon* Pursh, Lawrence Creek, Humboldt Co., Calif., June, 1925, Sept., 1930, H. E. Parks & J. P. Tracy.

Stomatogene Agaves (Ell. & Ev.) Theissen (Theissen, 1916)

Amphigenous on leaves of *Yucca mohavensis* Sarg., Camp Kearny, San Diego Co., Calif., Feb., 1929, H. E. Parks 3379.

Amphigenous on leaves of *Yucca Whipplei* Torr., La Jolla, San Diego Co., Calif., Feb., 1929, H. E. Parks.

Vertixore gen. nov.

Mycelium superficiale, dematioideum, ahyphopodiatum, setis nullis; perithecia superficialia, setosa, ostiolata; asci octospori, aparaphysati; sporae hyalophragmiae.

Mycelium superficial, dematoid, non-hyphopodiate, without setae; perithecia superficial, setose, ostiolate; asci 8-spored, no paraphyses; phragmosporous, hyaline.

Vertixore atronitidum sp. nov. (pl. 70, fig. 2; pl. 68, fig. 1; pl. 67, figs. 2, 3, 4)

Asterina anomala Cke. & Hk. in part
Chaetasterina anomala (Cke. & Hk.) Bub. in part
Chaetothyrium anomala (Cke. & Hk.) Theiss. & Syd. in part
Dimerosporium anomalum (Cke. & Hk.) Ell. & Ev. in part

Mycelium fuscidum, crustaceum, epiphyllum vel interdum hypophyllum, hyphopodiis nullis, non setosum, hyphis non constrictis; perithecia globosa, sessilia, 70–125 μ diam., appendiculis fuscis, septatis, simplicibus, acutis, 120–244×5–7 μ, in dimidio supero praedita, ostiolo in apicem poroideo; asci ventricosi vel subcylindracei, breviter stipitati, octospori, 43–62×12–17 μ, aparaphysati; sporidia clavata vel subfusiformia, hyalina, cellulis 5–8, 17–30×3–7 μ.

Mycelium dark, crustose, epiphyllous, occasionally hypophyllous, non-hyphopodiate, non-setose, hyphae not constricted; perithecia globose, sessile, black, lustrous, 70–125 μ in diameter, the upper half bearing dark, septate, simple, acute appendages, 120–244×5–7 μ, ostiole apical, poroid; asci ventricose to subcylindric, short-stipitate, 8-spored, 43–62×12–17 μ, no paraphyses; spores clavate to subfusiform, hyaline, 5–8-celled, 17–30×3–7 μ.

On living leaves of *Ceanothus thyrsiflorus* Esch. var. *griseus* Trel., Asilomar, Monterey Co., Calif., March, 1932, V. Miller, type, University of California Herbarium 498807.

On leaves of *Quercus agrifolia* Neé, Asilomar, Monterey Co., Calif., March, 1932, V. Miller.

On leaves of *Photinia arbutifolia* Lindl., Lake Phoenix, Marin Co., Calif., April, 1932, V. Miller, associated with *Chaetophomella setigera* (Pk.) Speg.; Ross, Marin Co., Calif., April, 1933, V. Miller, associated with *C. setigera;* Berkeley, Calif., spring, 1932, H. E. Parks; Sonoma Co., Calif., April, 1931, H. E. Parks 3621, 3622, both associated with *Capnodium Heteromeles* Cke. & Hk.; Napa Co., Calif., March, 1932, H. E. Parks, associated with *Phaeosaccardinula anomala.*

On leaves of *Umbellularia californica* Nutt., Inverness, Marin Co., Calif., March, 1931, H. E. Parks 3577, often associated with *Phaeosaccardinula anomala;* San Rafael, Marin Co., Calif., April, 1880, H. W. Harkness 1461, in part type of *Asterina anomala* Cke. & Hk.; Wildcat Canyon, Contra Costa Co., Calif., April, 1939, Lee Bonar, associated with *Capnodium tuba* Cke. & Hk.

Study of a portion of the type collection of *Asterina anomala* Cke. & Hk. (1881) reveals two fungi—*Phaeosaccardinula* and *Vertixore.* Eighteen leaves show only *Vertixore,* eight only *Phaeosaccardinula,* and only one leaf a mixture of the two genera. The mycelium, perithecia, and spores of each form correspond in every respect with the descriptions given in this paper under *Phaeosaccardinula anomala* and *Vertixore atronitidum.* Cooke was evidently puzzled by what he took to be the variability of the type material, for he follows his description with the comments that it was "a singular species" and that "sometimes setae are also found on the perithecia." The specific name "*anomala*" is retained for the *Phaeosaccardinula,* since the original description resembles that material more closely.

Vertixore can be differentiated from other members of the Hyalophragmiae of the Perisporiaceae in the following manner:

A Perithecia separate, not in a disk.
  B Perithecia ostiolate, setose .... *Vertixore*
  BB Perithecia non-ostiolate.
    C Perithecia setose .... *Dimeriellopsis*
    CC Perithecia glabrous .... *Mycophaga*
AA Perithecia ostiolate, glabrous, in a disk .... *Paropsis*

CAPNODIACEAE

Aithalomyces Rhododendri Woronichin (pl. 69) (Woronichin, 1926)

For over ten years a thick spongy fungal growth has been collected on the branches of *Arctostaphylos sensitiva* Jeps. on a single ridge of the south slope of Mt. Tamalpais, Marin County, California. *A. sensitiva* is common in the Tamalpais region. Yet the present fungus has been found nowhere else. The small area of occurrence has remained essentially the same and is abruptly limited. The transition from abundance to absence occurs between adjacent shrubs.

Aithalomyces Rhododendri was established by Woronichin as appearing on twigs of *Rhododendron chrysantum* Pall. on the shore of Lake Baikal, Siberia. He describes it as having black spongy cushions three to five millimeters thick, whereas on the Mt. Tamalpais *Arctostaphylos* the cushions may be twenty-five millimeters in thickness. The microscopic characters agree very well with Woronichin's description.

Capnodium caespitosum E. & E. (Ellis & Everhart, 1894)

Recorded on leaves of loquat, *Eriobotrya* (*Photinia*) *japonica* Lindl., Pasadena, Calif.

?Capnodium Coffeae Pat. (Patouillard & de Lagerheim, 1893)

On *Lithocarpus densiflorus* (H. & A.) Rehd., Inverness Ridge, Marin Co., Calif., Feb., 1932, Lee Bonar, associated with *Chaetasbolisia falcata.*

The identification must remain in question because the original description of the species was based on the imperfect stage (Delacroix, 1904). The outstanding characteristic of the species is the unusually long, simple, and narrow pycnidia, which on our material measure $400–918 \times 17–30\,\mu$, with ventricose swellings about three-fourths of the way up which may be from $22–55\,\mu$ wide. The hyaline spores are about $5–6 \times 2.5\,\mu$.

Capnodium elongatum Berk. & Desm.

(Berkeley & Desmazières, 1849; Ellis & Everhart, 1892)

On leaves and twigs of *Pittosporum* sp., Berkeley, Calif., April, 1893, W. C. Blasdale.

?Capnodium Footii Berk. & Desm. (Berkeley & Desmazières, 1849)

On *Photinia arbutifolia* Lindl., University of California Campus, Berkeley, spring, 1932, H. E. Parks, often associated with *Vertixore atronitidum* and *Phaeosaccardinula anomala.*

This species also has been described in the imperfect condition only; so our determination is uncertain. The pycnidia are elongated, usually simple, not inflated, tapering slightly toward the apex, $214–632 \times 20–51\,\mu$. The spores are hyaline and continuous, and remain massed together upon being extruded, $4–5 \times 2–2.5\,\mu$.

Capnodium Heteromeles Cke. & Hk. (Cooke & Harkness, 1884)

On leaves of *Photinia arbutifolia* Lindl., Sunol, Alameda Co., Calif., April, 1881, H. W. Harkness 2425, type in California Academy of Sciences; Berkeley, Calif., June, 1892, Marshall A. Howe 12; Berkeley, Calif., March, 1893, W. C. Blasdale, *Fungi Columbiani* 114, *N. Am. Fungi* 2918; between Knight's and Alexander Valley, Sonoma Co., Calif., April, 1931, H. E. Parks 3621, associated with *Vertixore atronitidum* and *Phaeosaccardinula anomala;* Lake Phoenix, Marin Co., Calif., April, 1932, V. Miller, associated with *Vertixore* and *Chaetophomella setigera.*

Capnodium Rhamni Cke. & Hk. (Cooke & Harkness, 1884)

On *Rhamnus californicus* Esch., Mt. Diablo, Contra Costa Co., Calif., May, 1881 (?), H. W. Harkness 2482, type in California Academy of Sciences; near Middletown, Lake Co., Calif., March, 1931, H. E. Parks 3581.

Capnodium tuba Cke. & Hk. (pl. 68, fig. 1) (Cooke & Harkness, 1884)

On *Umbellularia californica* Nutt., Palo Alto, Calif., April, 1881, H. W. Harkness 2395, type in California Academy of Sciences; Sausalito, Marin Co., Calif., June, 1892, Marshall A. Howe 4; Inverness, Marin Co., Calif., March, 1931, H. E. Parks 3577; Ross, Marin Co., Calif., April, 1932, V. Miller; Wildcat Canyon, Contra Costa Co., Calif., April, 1939, Lee Bonar, associated with *Vertixore atronitidum.*

Only the imperfect stage is known. Usually the pycnidia are simple columns. Rarely, when the growth is more luxuriant, the pycnidia undergo free dichotomous branching and the mycelium forms black, felty cushions on the leaves of the host.

Limacinia Lithocarpi sp. nov. (pl. 67, fig. 5)

Mycelium superficiale, epiphyllum, pallide brunneum, cellis hypharum elongatis, saepe ad septa constrictis, setis nullis; perithecia depresso-globosa, sessilia, pallide brunnea, glabra, membranacea, 102–224 μ diam., ostiolo nullo; asci octospori, 52–87×15–20 μ; paraphyses nullae; sporidia multiseriata, achromatica, elongato-fusiformia, saepe curvata, cellulis usque ad 14, 30–50× 3–6 μ.

Mycelium superficial, epiphyllous, light brown, cells of the hyphae elongated, often constricted at the septa, without setae; perithecia depressed-globose, sessile, light brown, glabrous, membranaceous, 102–224 μ in diameter, non-ostiolate; asci eight-spored, 52–87×15–20 μ; no paraphyses; spores multiseriate, colorless, elongate-fusiform, often curved, up to 14-celled, 30–50× 3–6 μ.

On living leaves of *Lithocarpus densiflorus* (H. & A.) Rehd., near Inverness, Marin Co., Calif., March, 1931, H. E. Parks 3573, type, University of California Herbarium 498808; Inverness Ridge, Marin Co., Calif., Feb., 1932, Lee Bonar; Van Duzen River, near Alton, Humboldt Co., Calif., March, 1931, H. E. Parks 3575, associated with *Ceuthocarpon conflictum* (Cke.) Berl.

Limacinia Lithocarpi is apparently quite near to *Phaeosaccardinula roseospora* v. Höhn., from which it differs mainly in the fact that the spores of the latter are muriform, whereas the spores of the former show no evidence of this.

Phaeosaccardinula anomala (Cke. & Hk.) comb. nov.
(pl. 70, fig. 1; pl. 67, fig. 6)

Asterina anomala Cke. & Hk. In part. 1881. Grevillea 9:87.
Meliolopsis Heteromeles Cke. & Hk. 1884. Grevillea 13:21.
Zukalia Heteromeles (Cke. & Hk.) Sacc. 1891. Syllog. Fung. 9:432.
Meliola Heteromeles (Cke. & Hk.) Berl. & Vogl. 1892. J. B. Ellis and B. M. Everhart, The North American Pyrenomycetes, p. 48.
Dimerosporium anomalum (Cke. & Hk.) Ell. & Ev. In part. 1892. J. B. Ellis and B. M. Everhart, The North American Pyrenomycetes, p. 35.
Chaetasterina anomala (Cke. & Hk.) Bub. In part, for California material. 1909. Ann. Nat. Mus., Vienna, 23:102.
Chaetothyrium anomala (Cke. & Hk.) Theiss. & Syd. In part. 1917. Ann. Myc. 15:477.
Chaetothyrium Heteromeles (Cke. & Hk.) Theiss. In part. 1917. Ann. Myc. 15:477.

Subiculum epiphyllous, superficial, dusty light brown, having a granular appearance, limited to irregular areas, hyphae consisting of torulose cells, without setae or hyphopodia; perithecia superficial on the mycelium, globose, soon collapsing, glabrous, sessile, brown, 112–184 μ in diameter, ostiole obscure; paraphyses none; asci eight-spored, 30–68×11–17 μ; spores biseriate, hyaline to subhyaline, muriform, fusoid, not constricted, 3–5 septate, 10–18×3–6 μ.

On the living leaves of *Photinia* (*Heteromeles*) *arbutifolia* Lindl., Sunol, Alameda Co., Calif., April, 1881, H. W. Harkness 2425, type of *Meliolopsis Heteromeles* Cke. & Hk., in California Academy of Sciences; Sonoma Co., Calif., April, 1931, H. E. Parks 3622; University of California Campus, Berkeley, spring, 1932, H. E. Parks; Napa Co., Calif., March, 1932, H. E. Parks.

On living leaves of *Umbellularia californica* Nutt., San Rafael, Marin Co., Calif., April, 1880, H. W. Harkness 1461, type of *Asterina anomala* Cke. & Hk., in part, in California Academy of Sciences; Inverness, Marin Co., Calif., March, 1931, H. E. Parks 3577.

On leaves of *Lithocarpus densiflorus* (H. & A.) Rehd., Inverness Ridge, Marin Co., Calif., Feb., 1932, Lee Bonar; Marin Co., Calif., March, 1931, H. E. Parks.

Often found associated with *Chaetasbolisia falcata, Vertixore atronitidum, Capnodium Footii,* or *Capnodium Heteromeles.*

The species is placed in *Phaeosaccardinula* because of the torulose, nonsetose mycelium, the collabent, glabrous perithecia, and the muriform spores. In spite of the poor type material of *Meliolopsis Heteromeles,* the microscopic characters could be checked, and the measurements were found to come well within those given above. Cooke's spore measurement of 40×8 μ is an error.

As explained in this paper under *Vertixore atronitidum,* the description of *Asterina anomala* is a combination of the characters of the two fungi which are present on the type material; namely, *Phaeosaccardinula anomala* and *Vertixore atronitidum.* Part of the type material of *Asterina anomala* corresponds in every particular with the recent collections of *Phaeosaccardinula anomala* studied. In none of the collections could the general aspect be described as "velvety"; it is instead merely "black, sooty." The absence of setae on the mycelium makes it impossible to use several of the generic names which we have reduced to synonymy. The spores of the type of *Asterina anomala* average 14×5 μ; hence the measurements given by Cooke refer to the *Vertixore*

material. The perithecia of the type average 127–173 μ; therefore Cooke's measurement of 80 μ refers to the *Vertixore* material, as does also the mention of setae on the perithecia.

It is improbable that the material listed by Bubak from Asia Minor as *Chaetasterina anomala* is the same as our California species, because the description on which he based his new combination represents a composite of the characters of two fungi.

Phaeosaccardinula dematia sp. nov. (pl. 68, fig. 2; pl. 67, figs. 8, 9)

Mycelium superficiale, epiphyllum, in ramulis in molibus laxibus, crassibus, atris saepe conspicuum, ex dematiis hyphis fuscis, rigidis, nimis ramosis, ex cellis muris rectis aut subtorulosis aut torulosis circumdatis compositum; perithecia in mole densa myceliale locata, globosa, collabenta, ostiolata, aliquanto tuberculosa, sine appendiculis, 27–150 μ; asci 62–98×10–23 μ, fasciculati cum stipitibus longis, obtusati, ventricosi, octospori; sporidia biserialia, brunnea, fusiformia-elliptica, cum 5–6 cellis, muriformia, in septis mediis constricta, 26–33x7–12.5 μ.

Pycnidia quoque submersa in crassa myceliale mole, 112–826×20–95 μ, fusca, subulata, non fimbriata, saepe cum tuberibus brunneis hyphoideis, simplicibus aut ramosis, muris rectis circumdatis; sporidia brunnea, flexuosa, acuminata, multum elongata, 40–75×4–7.5 μ, cum 8–16 cellis, cellae germinatione eorum multum constringerentur et torulosas atras hyphas efficiunt ut crescant.

Mycelium superficial, epiphyllous, often conspicuous on the twigs, in loose, thick, black masses consisting of dark brown, rigid, excessively branched, dematioid hyphae with cells straight-walled, subtorulose to torulose; perithecia resting in the dense mycelial mass, globose, collabent, ostiolate, somewhat tuberculate, without appendages, 27–150 μ; asci fasciculate, long-stipitate, obtuse, ventricose, eight-spored, 62–98×10–23 μ; spores biseriate, brown, fusiform-elliptical, 5–6-celled, muriform, constricted at the median septa, 26–33×7–12.5 μ.

Pycnidia also borne embedded in the thick mycelial mass, 112–826×20–95 μ, dark brown, subulate, simple or branched, non-fimbriate, often with simple or branched, straight-walled, brown hyphal outgrowths; spores brown, flexuous, acuminate, greatly elongated, 40–75×4–7.5 μ, 8–16-celled. The cells during germination become much constricted and give rise to dark, torulose hyphae.

On *Baccharis pilularis consanguinea* (DC.) Wolf (erect form of *B. pilularis*), Moss Beach, San Mateo Co., Calif., April, 1924, H. E. Parks 2139, type, University of California Herbarium 617322; Berkeley, Calif., May, 1893, W. C. Blasdale, Ellis & Everhart *Fungi Columbiani* 112 as "*Capnodium salicinum* (A. & S.) (?)"; Berkeley, Calif., Jan., 1894, Marshall A. Howe 52, labeled *Capnodium elongatum* Berk. & Desm.; Inverness, Marin Co., Calif., Feb., 1931, H. E. Parks, distributed by the University of California Herbarium, No. 257, as "*Capnodium salicinum* (A. & S.) Mont. (?)"; Wildcat Canyon, Contra Costa Co., Calif., April, 1939, Lee Bonar.

On *Baccharis pilularis typica* Wolf (prostrate form of *B. pilularis*), east of Point Reyes lighthouse, Marin Co., Calif., July, 1939, Lee Bonar.

On *Sequoia sempervirens* (Lamb.) Endl., Big Sur, Monterey Co., Calif., Aug., 1937, Lee Bonar, associated with *Chaetasbolisia falcata*.

On *Umbellularia californica* Nutt., Big Sur, Monterey Co., Calif., Aug., 1937, Lee Bonar.

On *Abies amabilis* (Dougl.) Forb., near Adelaide Lake, Mt. Rainier National Park, Washington, Sept., 1935, H. E. Bailey.

Portions of the type were sent to H. Sydow, who recommended assigning the material to *Phaeosaccardinula,* at least at present. The Ellis and Everhart material is labeled "sterile," but this was found not to be so. Actually, the fruiting bodies are identical with those of the type of *Phaeosaccardinula dematia.*

MICROPELTACEAE

Protopeltis Lithocarpi sp. nov.

Subiculum reticulum atrum superficialem in superficie folii supera formans, ab hospite facile secedens, ex hyphis parietibus rectis atque cellarum sinuosarum plectenchymaticarum tegeticulis raris compositum; ascomata dimidio-scutata, applanato-conica, glabra, membrana basilari distincta nulla, ostiolo certo absente, irregulariter immo ad apicem dehiscentia, scutello ex cellis sinuosis plectenchymatis composito, in medio fusco-brunneo et 90–132 μ lato, ad marginem hyalino, toto 142–183 μ lato; asci in matrice gelatinosa, subpyriformes, octospori, 21–27×10–13 μ; sporidia hyalina, elongato-ovata, cellulis 4, 10–15×2.5–4 μ.

Subiculum forming a superficial black reticulum over the upper surfaces of leaves, easily separating from the host, composed of straight-walled hyphae with occasional mats of sinuous plectenchymic cells that make up the ascomata; ascomata dimidiate-scutate, flat-conical, glabrous, without a distinct basal membrane, without definite ostiole but breaking irregularly at apex, scutellum composed of wavy plectenchymic cells, central portion dark brown, 90–132 μ, the outer portion composed of hyaline wavy cells, the entire shield 142–183 μ in diameter; asci in a gelatinous matrix, subpyriform, 8-spored, 21–27×10–13 μ; spores hyaline, elongate-ovate, 4-celled, 10–15×2.5–4 μ.

Epiphyllous on leaves of *Lithocarpus densiflorus* (H. & A.) Rehd., near Inverness, Marin Co., Calif., March, 1931, H. E. Parks 3573, type, University of California Herbarium 617323. Sometimes associated with *Limacinia Lithocarpi.*

SPHAERIACEAE

Acantharia echinata (E. & E.) Theiss. & Syd. (Theissen & Sydow, 1918)

Dimerosporium echinatum E. & E.

On *Quercus Wislizenii* A. DC., Mt. Diablo, Contra Costa Co., Calif., May, 1928, Lee Bonar.

On leaves of *Quercus chrysolepis* Liebm., Jackson, Amador Co., Calif., 1893, F. T. Bioletti, Feb., 1895, George Hansen; Yosemite National Park, Calif., May, 1931, H. E. Bailey; Smith River, Del Norte Co., Calif., July, 1933, Lee Bonar.

On *Quercus vaccinifolia* Engelm., Smith River, Del Norte Co., Calif., April, 1933, H. E. Parks 3998.

Aphanostigme lanugine sp. nov. (pl. 67, fig. 7)

Mycelium hypophyllum, fusco-brunneum, subiculum non constituens, hyphae non constrictae, pilos epidermales hospitis circumplicantes; perithecia dispersa, conica vel globosa, membranacea, 132–245 (300) μ diam., spinis flexuosus, acutis, 23–110×4 μ, undique dense praedita, ostiolo amplo; asci cylindracei, stipitati, octospori, 75–88×10 μ; paraphyses copiosae, filiformes, simplices; sporidia hyalina, clavata vel fusiformia, interdum curvata, biseriata, cellulis 4 vel 5, aliquando 6, 17–23×2.5–4 μ.

Mycelium hypophyllous, dark brown, not forming a subicle, hyphae not constricted, twining around the epidermal hairs of the host; perithecia scattered, conical to globose, membranaceous, 132–245 (300) μ in diameter,

thickly beset throughout with flexuous, acute spines, 23–110×4 μ, ostiole large; asci cylindrical, stipitate, 8-spored, 75–88×10 μ; paraphyses abundant, filiform, simple; spores hyaline, clavate to fusiform, sometimes curved, biseriate, 4–5-, occasionally 6-celled, 17–23×2.5–4 μ.

On living leaves of *Garrya elliptica* Dougl., Bolinas, Marin Co., Calif., fall, 1931, V. Miller, type, University of California Herbarium 498806.

The mycelium of this fungus is peculiar in its characteristic superficial growth on the abundant woolly epidermal hairs of its host, which it discolors. The perithecia are found on the leaf tissue at the base of the epidermal hairs.

The genus *Aphanostigme* (Sydow, H., 1926) was established on the one species, *A. Solani,* which has 4-celled spores. The characters of the material on *Garrya* agree perfectly with Sydow's generic description except in the matter of spore septation. Since variation in the number of cells in phragmospores is common in different species within a genus, the material is assigned to *Aphanostigme* in spite of its greater spore-cell range.

Pleosphaeria Citri (Pers.) Arnaud (Arnaud, 1910, 1911)

Capnodium Citri Berk. & Desm.

On leaves of *Citrus aurantium* L., Berkeley, Calif., June, 1892, Marshall A. Howe, March, 1893, W. C. Blasdale, *N. Am. Fungi* 2919, *Fungi Columbiani* 113.

Pleosphaeria salicina (Mont.) Arnaud (Arnaud, 1911)

On bark of *Baccharis pilularis consanguinea* (DC.) Wolf, near Inverness, Marin Co., Calif., Feb., 1931, H. E. Parks 3089; Guadaloupe Mines, Santa Clara Co., Calif., Feb., 1924, H. E. Parks 2033.

The material shows the setose, globose perithecia as well as the glabrous, elongated, *Capnodium*-like fruiting bodies as described by Arnaud. The material agrees in every particular with the characters set forth for *Pleosphaeria salicina.*

SPHAERIOIDACEAE

Chaetasbolisia falcata sp. nov. (pl. 67, fig. 10)

Mycelium epiphyllum, subiculum conspicuum fusco-brunneum constituens; pycnidia globosa, sessilia, brunnea, membranacea, 40–143 μ diam., magnum orbiculatumque ostiolum; spinae, solum circum ostiolum, rigidae, fuscissimae, robustae, curvae, aculeatae, non septatae, 25–50×3.7–7.5 μ; sporidia continua, hyalina, bacillaria, longitudine inconstantissima, 1.3–5 (raro 8–9)×1–2.5 μ.

Mycelium epiphyllous, forming a conspicuous dark-brown subicle; pycnidia globose, sessile, brown, membranaceous, 40–143 μ; ostiole large, poroid; spines only around the ostiole, rigid, deep fuscous, stout, curved, aculeate, non-septate, 25–50×3.7–7.5 μ; spores continuous, hyaline, rod-shaped, length very variable, 1.3–5×1–2.5 μ (rarely 8–9 μ long).

On living leaves and stems of *Lithocarpus densiflorus* (H. & A.) Rehd., Inverness Ridge, Marin Co., Calif., Feb., 1932, Lee Bonar, type, University of California Herbarium 498797; Marin Co., Calif., March, 1931, H. E. Parks 3573.

On *Umbellularia californica* Nutt., Inverness Ridge, Marin Co., Calif., Feb., 1932, Lee Bonar; Inverness, Marin Co., Calif., March, 1931, H. E. Parks 3577.

On *Polystichum munitum* Presl., Marin Co., Calif., Feb., 1932, Lee Bonar.

On *Rhamnus purshiana* DC., near Inverness, Marin Co., Calif., Feb., 1931, H. E. Parks 3572.

On *Woodwardia radicans* Sm., Big Sur, Monterey Co., Calif., Aug., 1937, Lee Bonar.

On *Sequoia sempervirens* (Lamb.) Endl., Big Sur, Monterey Co., Calif., Aug., 1937, Lee Bonar.

Chaetophomella setigera (Pk.) Speg. (Peck, 1893; Spegazzini, 1918)

On living leaves of *Quercus agrifolia* Neé, Berkeley, Calif., March, April, 1892, M. A. Howe, type of *Chaetophoma setigera* Pk.

Epiphyllous on *Photinia* (*Heteromeles*) *arbutifolia* Lindl., associated with *Vertixore atronitidum;* and on *Sequoia sempervirens* (Lamb.) Endl., Lake Phoenix, Marin Co., Calif., April, 1932, V. Miller.

? Polychaetella Araucariae (Thm.) Speg. (Spegazzini, 1918)

Capnodium Araucariae Thm.

Amphigenous on leaves of *Nerium Oleander* L., Berkeley, Calif., July, 1892, W. L. Jepson.

P. Araucariae is recorded on the branches and leaves of *Araucaria excelsa* from Coimbra. The accounts of the species are scarcely adequate, and therefore, in the absence of authentic determined material, the collection on *Nerium* must be referred with question to *P. Araucariae*. Briefly, the characters of the *Nerium* material are:

Mycelium torulose, superficial, without hyphopodia; perithecia elongated, attenuated upward, 61–133 μ wide at base, 20–46 μ wide at apex, 316–816 μ long, ostiolate, not fimbriate; no asci seen; spores brown, 3-septate, constricted, muriform, 12.5–20×6–10 μ. (Spores were seen out of the perithecia with the same characters as the above, except that they were dark brown, deeply constricted at the septa, 23–26×12–17 μ.)

Stilbaceae

Arthrobotryum spongiosum Hoerl (Hoerl, 1939)

On twigs and branches of *Libocedrus decurrens* Torr., *Chamaecyparis Lawsoniana* (Murr.) Parl., and *Pseudotsuga taxifolia* (Lamb.) Britt., Smith River, Del Norte Co., Calif., and Trinidad, Humboldt Co., Calif., H. E. Parks. Field observations have shown that this fungus is continuously present in these areas.

LIST OF SPECIES AND HOSTS

Species	Hosts
Acantharia echinata (E. & E.) Theiss. & Syd.	*Quercus chrysolepis* Liebm.
	Q. vaccinifolia Engelm.
	Q. Wislizenii A. DC.
Aithalomyces Rhododendri Wor.	*Arctostaphylos sensitiva* Jeps.
Aphanostigme lanugine sp. nov.	*Garrya elliptica* Dougl.
Arthrobotryum spongiosum Hoerl	*Chamaecyparis Lawsoniana* (Murr.) Parl.
	Libocedrus decurrens Torr.
	Pseudotsuga taxifolia (Lamb.) Britt.
Capnodium caespitosum Ell. & Ev.	*Eriobotrya (Photinia) japonica* Lindl.
? *Capnodium Coffeae* Pat.	*Lithocarpus densiflorus* (H. & A.) Rehd.
Capnodium elongatum Berk. & Desm.	*Pittosporum* sp.
? *Capnodium Footii* Berk. & Desm.	*Photinia arbutifolia* Lindl.
Capnodium Heteromeles Cke. & Hk.	*Photinia arbutifolia* Lindl.
Capnodium Rhamni Cke. & Hk.	*Rhamnus californicus* Esch.
Capnodium tuba Cke. & Hk.	*Umbellularia californica* Nutt.
Chaetasbolisia falcata sp. nov.	*Lithocarpus densiflorus* (H. & A.) Rehd.
	Polystichum munitum Presl.
	Rhamnus purshiana DC.
	Sequoia sempervirens (Lamb.) Endl.
	Umbellularia californica Nutt.
	Woodwardia radicans Sm.
Chaetophomella setigera (Pk.) Speg.	*Photinia arbutifolia* Lindl.
	Quercus agrifolia Neé
	Sequoia sempervirens (Lamb.) Endl.
Dimeriella Pseudotsugae sp. nov.	*Pseudotsuga taxifolia* (Lamb.) Britt.
Dimerium Juniperi Dearness	*Juniperus occidentalis* Hook.
Dimerosporium Abietis Dearness	*Abies grandis* Lindl.
Lasiobotrys affinis Harkness	*Lonicera hispidula* Dougl. var. *californica* Jeps.
Lasiobotrys Lonicerae Kze. & Schm.	*Lonicera ciliosa* Poir.
Limacinia Lithocarpi sp. nov.	*Lithocarpus densiflorus* (H. & A.) Rehd.
Meliola nidulans (Schw.) Cke.	*Gaultheria Shallon* Pursh
Phaeosaccardinula anomala (Cke. & Hk.) comb. nov.	*Lithocarpus densiflorus* (H. & A.) Rehd.
	Photinia arbutifolia Lindl.
	Umbellularia californica Nutt.
Phaeosaccardinula dematia sp. nov.	*Abies amabilis* (Dougl.) Forb., Washington
	Baccharis pilularis consanguinea (DC.) Wolf
	Baccharis pilularis typica Wolf
	Sequoia sempervirens (Lamb.) Endl.
	Umbellularia californica Nutt.
Pleosphaeria Citri (Pers.) Arnaud	*Citrus aurantium* L.
Pleosphaeria salicina (Mont.) Arnaud	*Baccharis pilularis consanguinea* (DC.) Wolf
? *Polychaetella Araucariae* (Thm.) Speg.	*Nerium Oleander* L.
Protopeltis Lithocarpi sp. nov.	*Lithocarpus densiflorus* (H. & A.) Rehd.
Stomatogene Agaves (Ell. & Ev.) Theiss.	*Yucca mohavensis* Sarg.
	Yucca Whipplei Torr.
Verticore atronitidum gen. and sp. nov.	*Ceanothus thyrsiflorus* Esch. var. *griseus* Trel.
	Photinia arbutifolia Lindl.
	Quercus agrifolia Neé
	Umbellularia californica Nutt.

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EXPLANATION OF PLATES

PLATE 67

Fig. 1. Ascus and spores of *Dimeriella Pseudotsugae.*

Fig. 2. *Vertixore atronitidum.* Spores.

Fig. 3. The same. Perithecia, showing spreading, septate appendages.

Fig. 4. The same. Ascus with spores.

Fig. 5. Spores of *Limacinia Lithocarpi.*

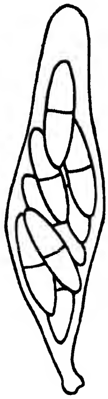
Fig. 6. Spores of *Phaeosaccardinula anomala.*

Fig. 7. *Aphanostigme lanugine,* showing asci, spores, and paraphyses.

Fig. 8. Conidia of *Phaeosaccardinula dematia.*

Fig. 9. Ascospores of *Phaeosaccardinula dematia.*

Fig. 10. Pycnidium of *Chaetasbolisia falcata* showing ostiole and falcate appendages.



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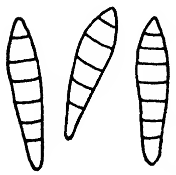

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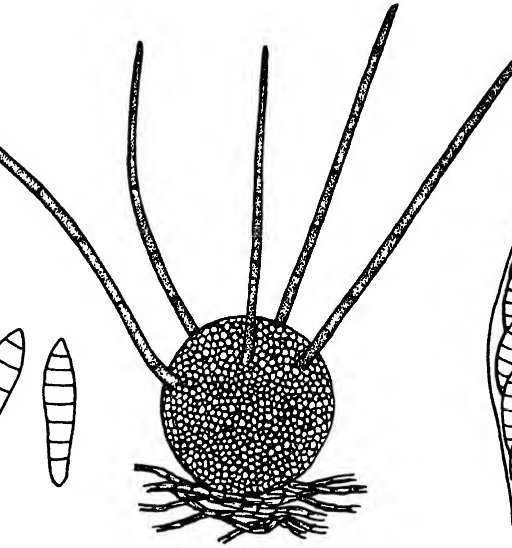

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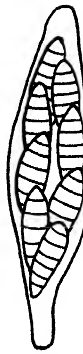

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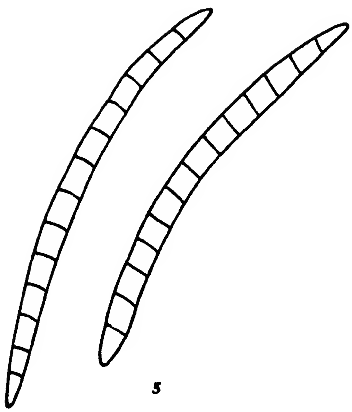

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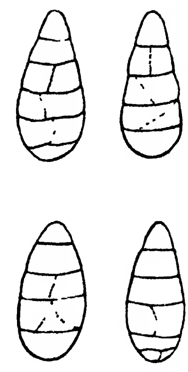

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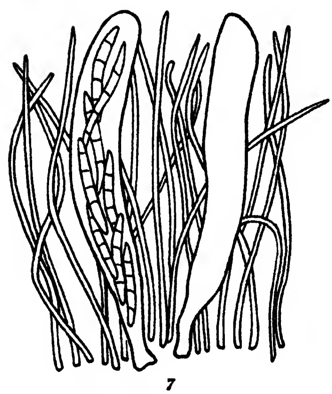

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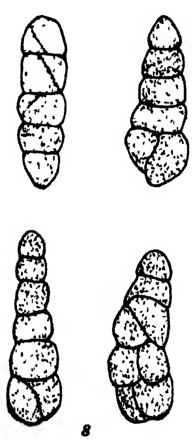

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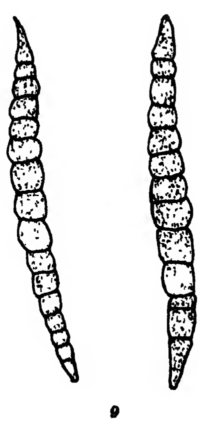

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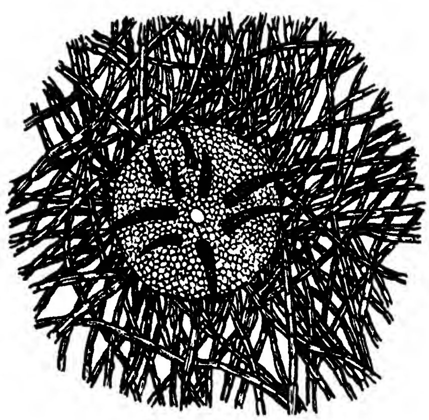

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PLATE 68

Fig. 1. *Vertixore atronitidum* and *Capnodium tuba* on *Umbellularia californica.*

Fig. 2. *Phaeosaccardinula dematia* on *Baccharis pilularis consanguinea.* The new growth is as yet unaffected by the fungus.

Fig. 1

Fig. 2

PLATE 69

Aithalomyces Rhododendri Wor. as it attacks branches of *Arctostaphylos sensitiva.* The leaves are only slightly affected.

PLATE 70

Fig. 1. *Phaeosaccardinula anomala* (Cke. & Hk.) comb. nov. Photomicrograph (×51) showing fungus in place on *Lithocarpus densiflorus*. This shows the peculiar granular-appearing mycelium and the characteristic collabent perithecia.

Fig. 2. *Vertixore atronitidum* gen. and sp. nov. Photomicrograph of perithecia in place on leaf of *Photinia arbutifolia*.

Fig. 1

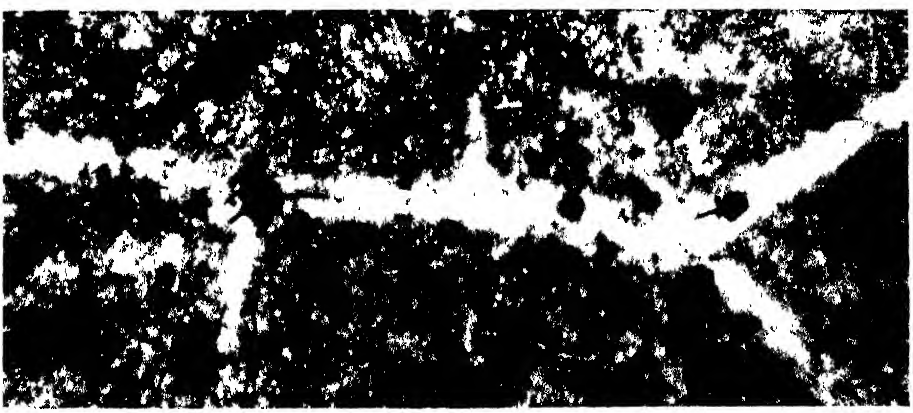

Fig. 2

INDEX

New names and species (as well as titles of contributions to this volume) are printed in **boldface** type.

ERRATA

p. 33, line 30. Insert the word *californica* after the word *coulteri*.

p. 74, footnote 43. Should read "See note 39 supra."

p. 81, line 10 from bottom. Omit the first citation (L. S. Rose 32380).

p. 87, line 7. Should read 5–10, not 5–8.

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